CITY AND COUNTY OF SAN FRANCISCO

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PUBLIC WORKS

REPORT ON

WATER POLLUTION CONTROL PLANTS

REPORT 2 – PHASE I

REDUCTIONS REQUIRED FOR TURBIDITY, COLOR, FLOATABLES, GREASE AND SETTLEABLE MATTER

SEPTEMBER 1971

BROWN AND CALDWELL
CONSULTING ENGINEERS

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September 1, 1971

F265A

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WATER POLLUTION CONTROL PLANTS - REPORT 2, PHASE I

In accordance with our agreement dated June 10, 1970, we are submitting Report 2, Phase I on the work covered by our agreement. Results of the work performed under Phase I are being presented in two sections, the first dealing with existing operational procedures and plant performances and the second with reductions necessary to achieve various levels of effluent quality as prescribed by the San Francisco Bay Regional Water Quality Control Board. The report submitted with this letter, covers the reductions necessary to achieve various levels of effluent quality with regard to turbidity, color, floatables, grease, and settleable solids at the City's three water pollution control plants.

We will be happy to meet with you or your staff to discuss our report at any time you may desire.

BROWN AND CALDWELL

Frank J. Kersnar

Frank J. Kersnar

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CONTENTS

CHAPTER 1

INTRODUCTION

By resolution Nos. 69-44 and 70-17, the San Francisco Bay Regional Water Quality Control Board required the City and County of San Francisco to submit an engineering report on the Southeast and North Point water pollution control plants evaluating the requirements and costs of producing effluents of specified characteristics. The resolutions state in part:

"The discharger is required to submit the following reports to this Board on or befor November 30, 1969:

A firm and detailed time schedule for the preparation of a preliminary engineering report and cost estimates for facilities needed to comply with the above requirements for floatables, turbidity, discoloration and settleable matter. For purposes of said report, the discharger shall use the following numerical ranges:

Reduction in water clarity:

5 to 30% in 90% of the determination made on any day in the area of greatest turbidity.

Floatables in the receiving water at any place:

10 to 50 mg/square meter

Grease in the effluent:

5 to 30 mg/l

Settleable matter in the effluent:

In any grab sample:

The arithmetic average of any six or more samples collected on any day - 0.5 ml/l/hr maximum.

80% of all individual samples collected during maximum daily flow over any 30-day period - 0.4 ml/l/hr

Any sample - 1.0 ml/l/hr maximum.

"... The Board expects the discharger to report on the type of facilities needed and the cost of complying with various numerical values within the above ranges ..." Although not required by the Regional Board, the City included the Richmond-Sunset water pollution control plant in the study.

Under the terms of an agreement for engineering services dated June 10, 1970, the required work is divided into two phases. Phase I involves a determination of existing conditions and Phase II involves an evaluation of process and operational changes. Separate reports are required for the two phases.

Objectives and Scope of Phase I Study

The primary objective of the Phase I study is to identify the quantities and qualities of the materials present in the influent, process streams and effluent of each of the city's three water pollution control plants. Under the terms of the agreement for engineering services, work to be performed included the following:

1. Review of present plant operations and processes to determine existing conditions, modes of operation, and sampling points.
2. Analysis of the influents, in-plant operation and process streams, effluents and receiving water conditions for the parameters listed in the Regional Board's resolutions.
3. Determination of reductions at average and peak flow conditions required to attain at least four levels of effluent and receiving water quality for which one or more levels shall comply with the ranges of objectives, requirements and goals as specified by the Regional Board.
4. Determination of the assimilative and dispersive capacity and background quality of the waters into which the Southeast water pollution control plant discharges and evaluation of the existing Southeast water pollution control plant outfall.
5. Preparation of a final report for Phase I presenting and discussing all information developed in this phase of the investigation and including recommendations and scope for investigations to be undertaken during Phase II of the study.

The report on Phase I investigations is submitted in two sections. The first section, submitted as Report 1, Phase I, covers a review of present plant operation and performance as included in the first two items listed above.

The second section, which this report includes, covers the reductions necessary to meet the Regional Board ranges of objectives, goals and requirements and the recommendations and scope for Phase II investigation.

Abbreviations used in this report are defined in Appendix A.

Office Work

Office work was concerned with the following principal activities:

1. A determination of the reductions necessary to meet the Regional Board ranges of objectives, goals and requirements.
2. A review of various chemical-physical treatment processes for the purpose of determining those processes best suited for providing the reductions required.
3. The preparation of Report 2 of Phase I.

Information and Data Made Available

Existing reports, data and preliminary determinations relating to the operation of the present water pollution control plant outfalls and to the proposed outfall extensions and revisions were furnished by those members of the Brown and Caldwell engineering staff who are involved in the preparation of the predesign study of submarine outfall sewers. Wet weather flow information came from preliminary data developed for the City by Engineering Science in conjunction with Federal Grant WPRD 258-01-68 FWQA for the Treatment of Combined Sewer Overflows by the Dissolved Air Flotation Process.

Progress Reports

Written reports on the progress of the study were made monthly to the Director of Public Works. Additionally, periodic meetings were held with the staff of the Sanitary Engineering Division to discuss the study progress and preliminary findings. Some information collected during the course of Phase I was also made available at the request of the Sanitary Engineering Division.

Acknowledgements

For their assistance during the study, we wish to express our appreciation to A. O. Friedland, R. T. Cockburn and W. R. Giessner and other members of the staff of the Division of Sanitary Engineering of the Bureau of Engineering and to K. Fraschina, J. H. Crafts, A. E. Bagot, W. C. Jow, L. T. Yew, R. Loucks, P. Shinn, N. Lago, A. Benas, C. Zern and D. McNulty of the Sewage Treatment Division of the Bureau of Water Pollution Control and other personnel of the Sewage Treatment Division of the Bureau of Water Pollution Control.

CHAPTER 2

REDUCTIONS NECESSARY TO MEET REGIONAL BOARD RANGES OF OBJECTIVES, GOALS AND REQUIREMENTS

Report 1 of the Phase I report covers the modes of operation and performance of the existing City and County of San Francisco water pollution control plants. Report 1 was also to include an investigation of existing receiving water conditions at the Southeast plant. Although some work was performed on this task, it could not be completed because of a rupture in an outfall siphon line from the effluent pumping station of the plant. Most of the receiving water conditions discussed in this report, therefore, have been determined from results obtained during the predesign study of the outfall sewers currently underway by Brown and Caldwell and the outfall steady-state dye experiments conducted by Brown and Caldwell in April of 1970.

Of the five variables mentioned in the Regional Board's resolution the first three, turbidity, floatables and discoloration, are directly related to the condition of the receiving waters. Work performed during the outfall sewer study indicates that the effect of any waste discharge on receiving water turbidity conditions will be in direct relation to the amount of dilution available at the point of discharge. Field data used to formulate this conclusion are included in this report as Appendix B. Reductions necessary to meet the proposed goals are determined, therefore, both for existing outfall dilutions and for the dilutions anticipated to result from the proposed outfall revisions and improvements.

Although all field data for this study was obtained during dry weather, some attempt is made in this report to ascertain the effect of wet weather flows on the Regional Board's reduction requirements. Characteristics of wet weather combined flow collected during various drainage basins studies carried out by the City during the past 3 to 4 years have been used to estimate wet weather effluent characteristics. Receiving water winter conditions have been analyzed from the data collected as part of the submarine outfall study.

North Point Water Pollution Control Plant

Resolution No. 70-17 of the San Francisco Bay Regional Water Quality Control Board sets forth the receiving water and waste stream waste discharge requirements and reporting requirements for the City and County of San Francisco North Point water pollution control plant. A copy of this resolution is included in this report as Appendix C-1.

Receiving Waters. Field data from the submarine outfall study indicates that the minimum background turbidity of the bay waters in the vicinity of the existing and proposed North Point outfalls is 1.6 JTU. Work done in conjunction with the submarine outfall study indicates true color rather than apparent color should be used to monitor the discharge effect on bay receiving waters.

As a first step in definition of the true color of Central Bay water and North Point plant effluent, samples of both were collected on November 10 and analyzed for light transmittance by a Bechman DU spectrophotometer. The bay water sample was collected near the proposed North Point outfall diffuser site at high slack water, and, therefore, represents water of maximum clarity for that time of year. Turbidity of the bay sample was 5 JTU and of the effluent sample 52 JTU. Both samples were filtered through a 0.45 micron millipore filter before analysis. Curves of transmittance versus wavelength for the visible light range of 400 to 800 millimicrons are shown on Fig. 2-1. As there shown, the light transmittance of the background bay sample ranged from 91 to 97 percent. For the effluent sample, light transmittance ranged from 65 to 93 percent, with all values above 75 percent except in the extreme edges of the visible light range. When calculated according to Standard Methods, the spectrophotometer readings indicate that of the three items, hue, brightness and saturation, the largest variance between the two samples took place in the brightness or percent

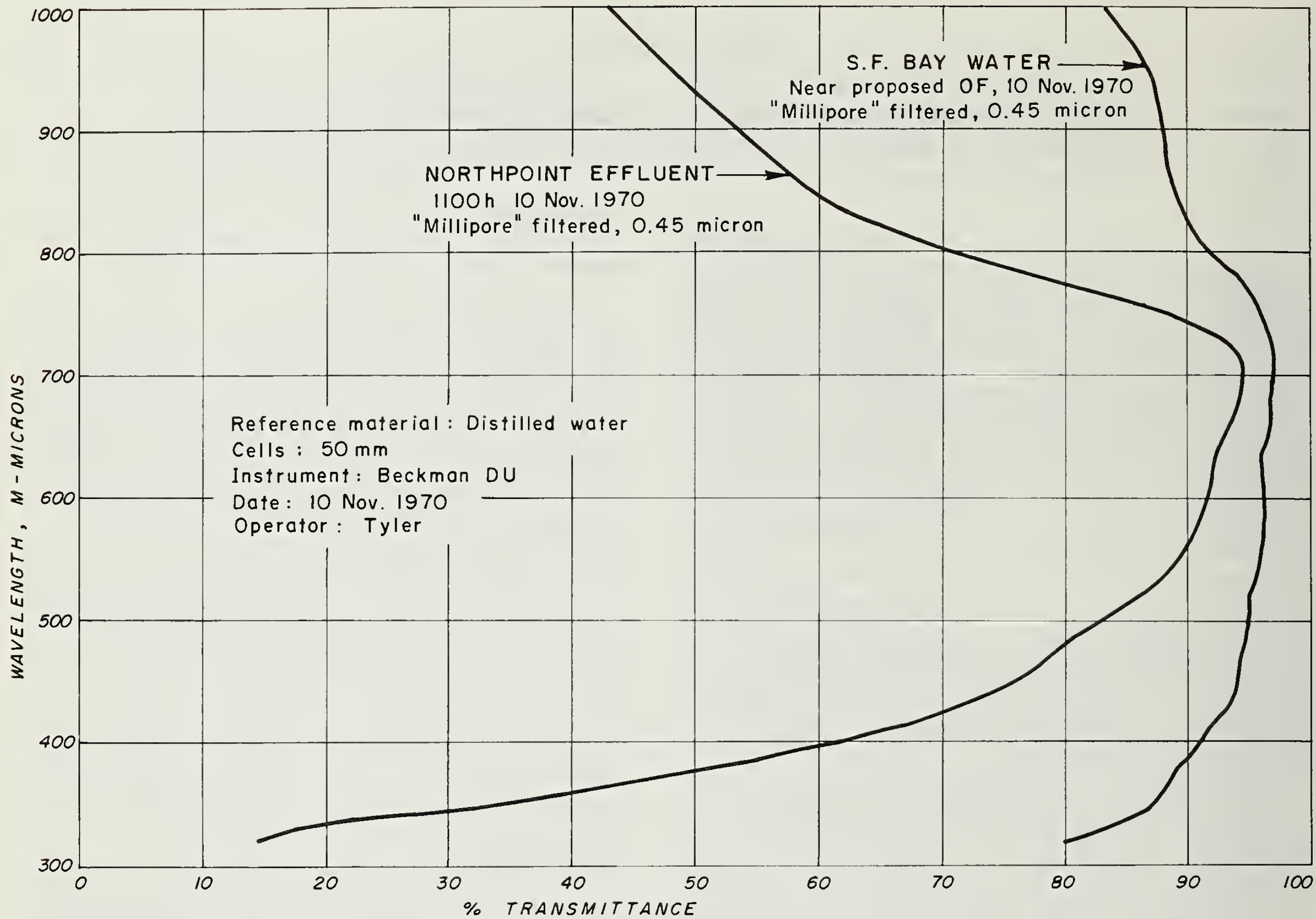


Figure 2 - 1

Scan, Transmittance vs. Wavelength Data for Selection of Wavelengths to be Investigated for Dilution Effects

luminance. The bay water sample indicated a luminance of 111 percent while the plant effluent showed a luminance of 90 percent.

The single laboratory determination provides a basis for only the most tentative initial conclusion, but it appears that true color will provide a valid basis for monitoring waste discharges. Further measurement of change in true color at various dilutions of plant effluent with bay water will be required to establish a reasonable range of deviation for enforcement of discharge requirements.

Steady-state dye tests conducted for the City by Brown and Caldwell in the spring of 1970, show that the existing North Point outfalls provide minimum dilutions of 3.3 to 1 in the effluent boils during dry weather flow periods. Calculations from the submarine outfall study indicate that with the proposed outfall improvements dilutions in excess of 100 to 1 will be obtained for all North Point effluent flows up to and including a maximum wet weather flow of 200 mgd.

Waste Stream. Field data on four of the five variables mentioned in the Regional Board resolution Nos. 69-44 and 70-17, were gathered and tabulated as part of Report 1 of Phase I of this study. As indicated earlier the true color values are the result of special samples and determinations. Turbidity and settleable matter calculations are based on maximum readings because of the reliability and repeatability of sampling and laboratory techniques. Floatables and grease sampling and laboratory techniques make determinations of the constituents more susceptable to unaccountable extremes. For this reason, average readings are utilized

in calculations involving these variables. Turbidity, floatables and grease results are determined from 24-hour composite samples. Settleable matter results reflect determinations made on individual grab samples.

Turbidity. Field data indicate the maximum effluent turbidity for the dry weather flows monitored at the North Point plant to be 62 JTU. When these flows are discharged into the receiving waters through the present outfalls it is calculated that the effluent trubidity must be reduced 99+ percent to meet the requirement of 5 percent clarity reduction and 97+ percent to meet the requirement of a 30 percent reduction. With the outfall improvements, calculated redutions in effluent turbidity of 84 percent will be required to meet the 5 percent clarity reduction and 7 percent to meet the 30 percent clarity reduction. Although no figures are available for effluent turbidity during wet weather flows, it is known from the submarine outfall studies that the background turbidity of the receiving water increases during periods of storm water runoff into the bay water. It is assumed that this increase, coupled with the continuing high outfall discharge dilution, will more than compensate for any possible slight increase in effluent turbidity.

Floatables. Field data indicate the average value of floatables in the North Point plant dry weather effluent during the monitored period to be 2 mg/l. Observations made as part of the steady-state dye studies previously referenced indicate that this value has to be reduced to zero to meet either of the Regional Board's floatable requirements with present discharge conditions. Analyses formulated as part of the submarine outfall study indicate that the maximum concentration of floatables in the vicinity of the improved outfall will amount to 15 mg/square meter. Discussion of this analysis is included in this report as Appendix D. On this basis, plant effluent floatable concentrations up to 6.7 mg/l will meet the 50 mg/square meter requirement and plant effluent concentrations of 2 mg/l will have to be reduced 33 percent to meet the 10 mg/square meter requirement. Data available on wet weather influent floatable concentrations seem to indicate that the average wet weather influent concentration will be less than the dry weather concentration. Therefore, even if the removal efficiency is less for the higher flows, the wet weather effluent floatables concentration will probably not exceed the dry weather concentration. As long as dilution obtained through the outfall diffuser remains at 100 to 1 for the wet weather flows, it is assumed the Regional Board's floatable requirements will be met by the same improvements required to meet the dry weather flow requirements.

Discoloration. Initial true color analysis of North Point effluent indicates that its affect on receiving water clarity is minimized by its similarity to bay waters in the visible light range. As long as commercial or industrial coloring wastes are controlled, it is assumed the turbidity JTU measurements will provide an indication of discoloration effect. Therefore, it is assumed receiving water clarity requirements will be met by the required turbidity reductions.

Grease. Field data indicate the average value of grease in the North Point plant effluent to be 38 mg/l. To meet the Regional Board's requirement of 5 mg/l, the effluent grease concentration must be reduced 87 percent. To meet the 30 mg/l requirement, effluent grease concentration must be reduced 21 percent.

Wet weather combined flow studies indicate that influent grease concentrations for wet weather flows decrease, after an initial increase of very short duration, to about 20 percent of dry weather concentrations. It is anticipated, however, that the removal efficiency within the plant will also decrease substantially during these periods of higher flow. If the wet weather influent concentration is assumed to decrease to approximately 11 mg/l and removal efficiency is assumed to decrease to 10 percent, the wet weather effluent grease concentration will be approximately 10 mg/l and will require a 50 percent reduction to meet the Regional Board's 5 mg/l requirement and no reduction to meet the 30 mg/l requirement.

Settleable Matter. Field data indicate that the settleable matter in individual samples of North Point effluent collected during period of maximum daily flow quite often measured 0.6 ml/l/hr and that for short periods each day exceeded 1.0 ml/l/hr, often reaching peaks of

1.5 ml/l/hr. To meet the Regional Board's requirements of 0.4 ml/l/hr for 80 percent of all individual samples collected during maximum daily flow and 1.0 ml/l/hr for any sample, the settleable matter in the plant effluent must be reduced by 33 percent.

There is some indication in the wet weather combined flow studies that influent settleable matter concentrations increase slightly during the higher wet weather flows. Much of this increase, however, seems to be caused by the presence of easily settled inorganic matter. It is assumed, therefore, that the effluent settleable matter concentration in wet weather will not vary greatly from the dry weather concentrations. The 33 percent reduction indicated for dry weather flows should also, therefore, satisfy the Regional Board's requirements for wet weather flows.

Richmond-Sunset Water Pollution Control

At the present time, the Richmond-Sunset water pollution control plant of the City and County of San Francisco is operating under Resolution No. 67-2 of the San Francisco Bay Regional Water Quality Control Board. While this Resolution does not require a report similar to that required for the North Point and Southeast plants, the City included the Richmond-Sunset plant in this study with instructions to apply similar requirements to those of the other two plants. A copy of the present resolution is included in this report as Appendix C-2.

Receiving Waters. Minimum data collected as part of the submarine outfall study indicate that the background turbidity of the waters in the vicinity of the existing and proposed Richmond-Sunset outfalls closely approximates that found at the North Point outfall sites. For purposes of this study, therefore, we have assumed this minimum background turbidity to be 1.6 JTU. No true color determinations were made of the receiving waters in the vicinity of the existing or proposed Richmond-Sunset outfalls. For the purpose of this study, it is assumed these receiving waters will be similar to those found in the Central Bay.

No dye tests were conducted at the existing Richmond-Sunset outfall discharge. As indicated in Report 1, this discharge is at the shoreline and provides negligible dilution. For the purposes of this study, the dilution of the existing outfall is assumed to be 1 to 1. Final studies determining the exact location of the proposed new Richmond-Sunset submarine outfall diffusers are not yet complete. Preliminary data, however, indicate that every site under consideration will provide dilutions in excess of 100 to 1 for all effluent flows up to and including a maximum wet weather flow of 70 mgd.

Waste Stream. Field data for all variables mentioned in the Regional Board resolution Nos. 69-44 and 70-17, except color, were gathered and tabulated as part of Report 1 of Phase I of this study. No true color determinations were made of the Richmond-Sunset effluent. As for the North Point plant, turbidity and settleable matter calculations are based on maximum readings and floatable and grease calculations on average readings. Grab and composite sample applications are as indicated for North Point.

Turbidity. Field data indicate the maximum effluent turbidity for the dry weather flows monitored at the Richmond-Sunset plant to be 57 JTU. When these flows are discharged into the receiving waters through the present outfall it is calculated that the effluent turbidity must be reduced 99+ percent to meet the requirement of 5 percent clarity reduction and 98+ percent to meet the requirement of a 30 percent clarity reduction. With the proposed new outfall it is calculated that the effluent turbidity will need to be reduced 86 percent to meet the 5 percent clarity reduction and 15 percent to meet the 30 percent clarity reduction. Although no figures are available for effluent turbidity during wet weather flows, it is known from the submarine outfall studies that the background turbidity of the receiving water increases during periods of storm water runoff into the bay and ocean waters. It is assumed that this increase, coupled with the continuing high outfall discharge dilution of the new outfall, will more than compensate for any possible slight increase in effluent turbidity.

Floatables. Field data indicate the average value of floatables in the Richmond-Sunset plant dry weather effluent during the monitored period to be 2.5 mg/l. For the minimum

dilution obtained at the existing outfall, effluent floatable concentration has to be reduced to zero to meet either of the Regional Board's floatable requirements. No analyses have been formulated as yet for the maximum concentration of floatables estimated for the vicinity of the new proposed outfall. However, it is assumed that a conservative estimate would be that the present effluent will result in a maximum floatable concentration of about 20 mg/square meter. On this basis, plant effluent floatable concentrations up to 6.25 mg/l will meet the 50 mg/square meter requirement and plant effluent concentrations of 2.5 mg/l will have to be reduced 50 percent to meet the 10 mg/square meter requirement. Those figures which are available on wet weather influent floatable concentrations seem to indicate that the average wet weather influent concentration is less than the dry weather concentration. Therefore, even if the removal efficiency is less for higher flows, the wet weather effluent concentration will probably not exceed the dry weather effluent concentration. As long as dilution through the outfall diffuser remains at 100 to 1 for wet weather flows, it is assumed the Regional Board's floatable requirements will be met by the same improvements required to meet dry weather flow requirements.

Discoloration. It is assumed that the true color relationships between North Point effluent and the Central Bay receiving water will exist for the Richmond-Sunset effluent and ocean receiving waters and that as long as commercial and industrial coloring wastes are controlled, the turbidity JTU measurements will provide an indication of discoloration effect.
Therefore, it is assumed the required turbidity reductions indicated above will also be sufficient to meet receiving water clarity requirements with respect to true color.

Grease. Field data indicate the average value of grease in the Richmond-Sunset plant effluent to be 41 mg/l. To meet the Regional Board's requirements ot 5 mg/l, the effluent grease concentration must be reduced 88 percent. To meet the 30 mg/l requirement, effluent grease concentration must be reduced 27 percent.

Wet weather combined flow studies indicate that influent grease concentrations for wet weather flows decrease fairly rapidly to about 15 percent of dry weather concentrations. It is anticipated, however, that the removal efficiency within the plant will also decrease substantially during these periods of higher flow. If the wet weather influent concentration is assumed to decrease to approximately 8 mg/l and removal efficiency is assumed to decrease to 5 percent, the wet weather effluent grease concentration will be approximately 7.5 mg/l and will require a 33 percent reduction to meet the Regional Board's 5 mg/l requirement and no reduction to meet the 30 mg/l requirement.

Settleable Matter. Field data indicate that for short periods each day the Richmond-Sunset effluent settleable matter equalled or exceeded 1.0 ml/l/hr, often reaching peaks of 1.5 ml/l/hr. To meet the Regional Board's requirement of 1.0 ml/l/hr for any sample, the settleable matter in the plant effluent must be reduced by 33 percent.

There is some indication in the wet weather combined flow studies that influent settleable matter concentrations increase slightly during the higher wet weather flows. Much of this increase, however, seems to be caused by the presence of easily settled inorganic matter. It is assumed, therefore, that the effluent settleable matter concentration in wet weather flows will not vary greatly from the dry weather concentrations. The 33 percent reduction indicated for dry weather flows should also satisfy the Regional Board's requirements for wet weather flows.

Southeast Water Pollution Control

Resolution No. 69-44 of the San Francisco Bay Regional Water Quality Control Board sets forth the receiving water and waste stream waste discharge requirements and other requirements and conditions for the City and County of San Francisco Southeast water pollution control plant. A copy of this resolution is included in this report as Appendix C-3.

Receiving Waters. Field data indicate the median value of background turbidity in the bay waters in the vicinity of the existing out-

fall to be 2.8 JTU. No true color determinations were made of the receiving waters in the vicinity of the existing Southeast outfall. For the purpose of this study, it is assumed these receiving waters will be similar to those found in the Central Bay.

Steady-state dye tests conducted for the City by Brown and Caldwell in the spring of 1970, show that the existing Southeast outfall provides a minimum dilution of 52.5 to 1 for dry weather flows. Calculations made as part of the submarine outfall study indicate that the existing outfall will provide dilutions in excess of 40 to 1 for effluent flows up to and including a maximum wet weather flow of 70 mgd. In addition to the outfall dilution, it has been assumed that the existing effluent pumping station will provide a 1 to 1 dilution of all dry weather effluents prior to their discharge into the submarine outfall.

Waste Stream. Field data for all the variables mentioned in the Regional Board resolution Nos. 69-44 and 70-17, except color, were gathered and tabulated as part of Report 1 of Phase I of this study. No true color determinations were made of the Southeast effluent. As indicated for North Point data, Southeast turbidity and settleable matter calculations are based on maximum readings and floatable and grease calculations on average readings. Grab and composite sample applications are as indicated for North Point.

Turbidity. Field data indicate the maximum turbidity for the dry weather flows monitored at the Southeast plant to be 100 JTU. When these flows are discharged into the receiving waters through the present outfall without effluent pumping station dilution, the effluent trubidity must be reduced 93 percent to meet the requirement of 5 percent clarity reduction and 56 percent to meet the requirement of a 30 percent clarity reduction. When the effluent pumping station is used for the dilution of dry weather flows prior to their discharge, the effluent turbidity will need to be reduced 89 percent to meet the 5 percent clarity reduction and 33 percent to meet the 30 percent clarity reduction. Although no figures are available for effluent turbidity during wet weather flows, it is known from the submarine outfall studies that the background turbidity of the water increases during periods of storm water runoff into the bay waters. It is assumed that this increase, coupled with wet weather outfall discharge dilution, will compensate for any possible slight increase in effluent turbidity. It should be noted here, however, that the existing outfall system limits wet weather flow dilution to less than half that available during dry weather.

Floatables. Field data indicate the average value of floatables in the Southeast plant dry weather effluent during the monitored period to be 3.25 mg/l. No data has yet been collected to determine the maximum concentration of floatables estimated for the vicinity of the existing outfalls. However, it is assumed that with the present dispersion and dilution, the Southeast dry weather effluent will produce maximum floatable concentrations of about 30 mg/square meter. If this assumption is accurate, the dry weather plant effluent concentration of 3.25 mg/l will have to be reduced 67 percent to meet the 10 mg/square meter requirements. No reduction is required to meet the 50 mg/square meter requirement. When the effluent pumping station dilution is in operation, it is estimated the Southeast dry weather effluent will produce maximum floatable concentrations in the order of 25 mg/square meter. With this assumption dry weather plant effluent floatable concentrations up to 6.5 mg/l will meet the 50 mg/square meter requirements and dry weather plant effluent concentrations of 3.25 mg/l will have to be reduced 60 percent to meet the 10 mg/square meter requirements.

Those figures which are available from the wet weather combined flow studies on wet weather influent floatable concentrations seem to indicate that the average wet weather influent concentration is less than the dry weather concentration. Therefore, even if

the removal efficiency is less for the higher flows, the wet weather effluent concentration will probably not exceed 67 percent of dry weather effluent concentration. Since the combined effluent pumping and outfall discharge dilution of dry weather flows is reduced to only the outfall discharge dilution for wet weather flows, it is estimated that these flows may produce maximum floatable concentrations of about 45 mg/square meter. On this basis, wet weather plant effluent floatable concentrations up to 2.4 mg/l will meet the 50 mg/square meter requirement and wet weather plant effluent concentrations of 2.15 mg/l will have to be reduced 78 percent to meet the 10 mg/square meter requirements.

Discoloration. It is assumed that the true color relationships between North Point effluent and the Central Bay receiving waters will exist for the Southeast effluent and receiving waters and that as long as commercial and industrial wastes are controlled, the turbidity JTU measurements will provide an indication of discoloration effect. Therefore, it is assumed that the required turbidity reductions will also satisfy the receiving water clarity requirements with respect to true color.

Grease. Field data indicate the average value of grease in the Southeast plant effluent to be 62 mg/l. To meet the Regional Board's requirements of 5 mg/l, effluent grease concentration must be reduced 92 percent. To meet the 30 mg/l requirement, effluent grease concentration must be reduced to 52 percent.

Wet weather combined flow studies indicate that influent grease concentrations for wet weather flows decrease fairly rapidly to approximately 30 percent of dry weather concentrations. It is anticipated, however, that the removal efficiency within the plant will also decrease substantially during these periods of higher flow. If the wet weather influent concentration is assumed to decrease to approximately 20 mg/l and removal efficiency is assumed to decrease to 5 percent, the wet weather effluent grease concentration will be approximately 19 mg/l and will require a 74 percent reduction to meet the Regional Board's 5 mg/l requirement and no reduction to meet the 30 mg/l requirement.

Settleable Matter. Field data indicate that the settleable matter in individual samples of Southeast effluent collected during periods of maximum daily flow average 1.2 ml/l/hr, reaching a peak of 3.0 ml/l/hr. To meet the Regional Board's requirement of 0.4 ml/l/hr for 80 percent of all individual samples collected during maximum daily flow and 1.0 ml/l/hr for any sample, the settleable matter in the plant effluent must be reduced by 67 percent.

There is some indication in the wet weather combined flow studies that the influent settleable matter concentrations increase slightly during the higher wet weather flows. Much of this increase, however, seems to be caused by the presence of easily settled inorganic matter. It is assumed, therefore, that the effluent settleable matter concentration in wet weather will not vary greatly from the dry weather concentrations. The 67 percent reduction indicated for dry weather flows should also satisfy the Regional Board's requirements for wet weather flows.

Summary

Tables 2-1 and 2-2 have been prepared to summarize the percent reductions and effluent concentrations required to meet the Regional Board requirements. The discoloration variable has not been included because of the lack of specific discharge requirements and the assumption that its effect on receiving water clarity is closely related to turbidity measurements.

Table 2 - 1

Turbidity and Floatable Reductions Necessary to Meet Receiving Water Requirements

Water pollution control plant	Turbidity requirement					Floatables requirement				
	Exist eff JTU	For 5 percent reduction in receiving water clarity		For 30 percent reduction in receiving water clarity		Exist eff mg/l	For concentration of 10 mg/sq m		For concentration of 50 mg/sq m	
		Required reduction percent	Resulting effluent JTU	Required reduction percent	Resulting effluent JTU		Required reduction percent	Resulting effluent mg/l	Required reduction percent	Resulting effluent mg/l
North Point										
Existing outfalls	62	99	0.3	97	1.6	2.0	100	0	100	0
Improved outfall	62	84	9.6	7	58	2.0	33	1.3	-	6.7
Richmond-Sunset										
Existing outfall	57	99	0.2	98	1.0	2.5	100	0	100	0
New outfall	57	86	8	16	48	2.5	50	1.2	-	6.2
Southeast										
Existing outfall w/o effluent pumping	100	93	7.4	56	44	3.2	67	1.1	-	5.4
Existing outfall with effluent pumping	100	89	11.2	33	67	3.2	60	1.9	-	6.5

Table 2 - 2

Grease and Settleable Matter Reductions Necessary to Meet Waste Discharge Requirements

Water pollution control plamt	Grease requirement			Settleable matter requirement			
	Exist eff mg/l	Percent reductions required		Maximum daily flow		Any sample	
		For effluent concentration of 5 mg/l	For effluent concentration of 30 mg/l	Existing average ml/l/hr	Percent reduction required for 0.4 ml/l/hr	Existing maximum ml/l/hr	Percent reduction required for 1.0 ml/l/hr
North Point	38	87	21	0.6	33	1.5	33
Richmond-Sunset	41	88	27	0.4	0	1.5	33
Southeast	62	92	52	1.2	67	3.0	67

CHAPTER 3

RECOMMENDATIONS AND SCOPE FOR PHASE II INVESTIGATIONS

Field observations, information and data from Report 1 of Phase I, and the reduction requirements of Chapter 2 indicate there are at least four treatment alternatives which should be investigated in Phase II of this study to ascertain the most economic way to meet Regional Board requirements. Investigations to date also indicate that these four alternatives are equally applicable to the waste streams of all three plants. These alternatives include: (1) improvements to existing primary treatment; (2) chemical treatment; (3) flotation treatment; and (4) biological treatment.

Improvements to Existing Primary Treatment

Records for the last two years of operation of the primary treatment plant of the Central Contra Costa Sanitary District in Concord indicate that while operating on standard strength fresh sewage with peak flows in excess of three times average design dry weather flow, the plant has never produced settleable matter concentrations in the effluent exceeding 0.90 ml/l/hr or a settleablematter concentration arithmetic average of daily samples exceeding 0.50 ml/l/hr. These records also indicate that the settleable matter concentration of 80 percent of all individual samples collected during maximum daily flow over any 30-day period has exceeded 0.40 ml/l/hr only six times in the two year period. Closer inspection of these records indicates that all but three of these excessive resdings might have been eliminated if the samples had been taken each day instead of only 6 to 8 days per month. During the three 30-day periods when the settleable matter concentration of 80 percent of the samples exceeded 0.40 ml/l/hr, monthly flows averaged approximately 1½ times the plants average design dry weather flow capacity of 25 mgd.

As reported in Chapter 2, all three of the existing San Francisco plant effluents exceeded the 1.0 ml/l/hr maximum settleable matter concentration almost daily during the sampling period. Modifications to provide more efficient primary treatment is therefore the first alternative that should be investigated at each of the three plants. Visual inspections also indicate that the feasibility of modifying all plants to update power and control functions and to improve oder control, housekeeping, ventilation and preventive- type maintenance facilities should be investigated. Investigations for the North Point and Richmond-Sunset plants should reflect conditions to be expected after major outfall improvements have been completed. Under existing disposal conditions, attainable with a primary effluent.

Chemical Treatment

While effluents from a properly functioning primary treatment plant may meet the settleable matter requirements and may, depending on outfall conditions, also meet the turbidity, floatable and discoloration requirements they will seldom, if ever, have a grease concentration which will meet the grease requirements stipulated by the Regional Board. To achieve the grease reductions required, some additional treatment must be provided. This additional treatment capacity may either be incorporated into existing structures or constructed into additional treatment facilities. Initially, additional treatment by means of chemicals seems to be the most promising for full utilization of existing structures with minimum new construction.

Chemical treatment involves addition of chemicals to the flow under conditions of rapid mixing, the flocculation of the chemical and sewage mix for a limited period of time to assure a homogenous mixture, and the settling out of the chemical and sewage solids. While it is known that chemical treatment can accomplish grease reductions of the magnitude required, the exact chemical dosage re-

quired varies in relationship to the raw sewage involved. To develop criteria for a given installation, it is usually necessary to perform pilot studies under actual operating conditions with the raw sewage involved.

Chemical treatment pilot studies should include test runs with various dosages of lime, ferric chloride and alum. In addition, studies should also include the determination of proper flocculation time and the best means of returning the effluent to an acceptable pH. Some recognition must be made od the additional loadings the chemical treatment processes will place on solids pumping, treatment and disposal facilities. Sufficient data should be collected from the pilot studies to assess this effect on the existing treatment plants.

Although preliminary information indicates that chemical treatment will also reduce turbidity, true color, and floatables to acceptable limits, pilot plant studies must be made to provide confirmation. If there is doubt on the required reduction of any of these variables, it is expected that studies of combinations of chemical treatment with micro-straining, filtration, carbon absorption and flotation will have to be made.

Flotation Treatment

Information developed by the Chain Belt Company in 1965 indicates that flotation treatment together with and following primary sedimentation is capable of removing from 80 to 90 percent of the total grease contained in raw sewage. This reduction comes close to meeting the complete range of the Regional Board's requirements for two of the three plants. If this degree of removal can be reliably obtained without primary sedimentation, the cost of application to the existing facilities would be substantially reduced.

Dissolved air flotation involves the recycling of approximately 25 to 40 percent of the plant effluent through pressurized aeration tanks. When the supersaturated recycled effluent is discharged from the pressure tanks, it is rapidly mixed with the sewage influent and the resulting mixture directed immediately into the flotation tanks. The thoroughly mixed supersaturated effluent releases its dissolved air in small bubbles which, as they rise to the tank surface, pick up the suspended particles of grease and solids. Full tank skimmers move the floating material to a single collection point where it is removed from the tank surface and deposited in a collection chamber. If flotation tanks are used without primary sedimentation, solids collection equipment is also required to remove the heavier debris from the bottom of each tank. Although some applications of this process have proven highly successful in the removal of grease, no data is available of its effect on turbidity, true color or floatables.

Pilot plant studies under actual operating conditions with the raw sewages involved should be made to assure the applicability of this treatment process. If there is doubt on the required reduction of any of these variables, it is expected that studies of combinations of flotation with micro-straining, filtration, carbon absorption and chemical pretreatment will be made.

Biological Treatment

Although other considerations often limit the applicability of this type of treatment, results from many existing installations indicate that primary treatment followed by biological treatment utilizing the activated sludge process with secondary sedimentation will probably provide the reductions necessary to meet the Regional Board's requirements. The only possible exception is the requirement involving true color. As the removal of dissolved solids is not a major consideration, it is possible that the contact stabilization type of activated sludge process will provide the most economical treatment of this type. Contact stabilization minimizes aeration tank detention time, thereby minimizing land requirements and tank structures and usually achieves a BOD removal of about 85 percent. Ample secondary sedimentation tank capacity is necessary to assure the required reductions of turbidity and floatables.

Biological treatment parameters are well known and documented, so there seems to be no need for pilot work to develop their application to this study. If this alternative should turn out to be the best, after all the facts have

been investigated, it is recommended that some pilot plant work be undertaken to determine whether the involved raw sewage contains any substance which may inhibit the functioning of the biological treatment process. These studies should also be directed toward the possibility of operating without primary treatment and toward the reductions which may be attained in true color. If color is not reduced sufficiently by the biological process, it is expected that studies on the combination of biological treatment followed by carbon adsorption will have to be made.

North Point Water Pollution Control

Limited land for additional treatment facilities and its cost, overshadow all other considerations at the North Point plant. Every attempt must be made to develop a treatment process which will fully utilize all existing facilities. On this basis there seems to be little question that modifying existing plant facilities, including outfall improvements, must be considered the first alternative to be investigated, Other alternatives to be investigated should include chemical treatment, both with and without pimary sedimentation, and chemical pretreatment. Biological treatment is not considered a reasonable alternative for investigation at this location because of the relatively large land area required for the facilities involved. It is anticipated that should additional treatment facilities be necessary, effluent pumping will be required.

In all discussion relating to improvement of the North Point plant, it is assumed that the outfall improvements recommended in the separate submarine outfall study will be constructed.

Existing Plant Modifications. To improve its efficiency and operation, the following modifications to the North Point plant should be investigated:

1. Elimination of raw sewage pump sumps, installation of variable speed pump drives, increase of pumping capacity, increase of speed of operation of influent sluice gate, and provision of an automatic influent level control system for pump and influent gate control.

2. Remodeling of existing bar screens to assure reliable operation for all flows up to 200 mgd and elimination of manual handling of screenings.

3. Remodeling of existing grit removal and handling system to increase removal efficiency and handling reliability.

4. Improving individual pump discharge isolation gates in pump discharge structure and providing air agitation systems for distribution channels from discharge structure to preaeration-sedimentation tanks.

5. Remodeling preaeration - sedimentation tanks by providing new preaeration diffuser equipment, new sludge cross collector channels and equipment about 100 feet from the influent end of tank, new sludge longitudinal collector equipment, new scum skimming and collection equipment, and new submerged effluent collection launders with effluent control gates and sedimentation tank level control system.

6. Elimination of existing raw sludge and scum pumping system, including force main pumps and sumps, by providing new solids handling gallery under the preaeration-sedimentation cross collector channels. The gallery would house new raw sludge and scum pumps of the progressive cavity, positive displacement type. Raw sludge pumps would be variable speed with control based on the sludge blanket level in the cross collector hopper.

7. Elimination of the existing chlorination contact structure by utilizing the effluent control valve turbulence for rapid mixing and the new outfall for the contact structure.

8. Enlarging sludge handling facilities by installation of a second force main to the Southeast treatment plant and chlorination of solids to inhibit bacterial action in the force main.

In addition to the above, modifications to the North Point plant ventilation and odor control systems should be investigated. Sewage turbulence and agitation should be eliminated. Critical areas should be isolated and ventilated by a special exhaust system with deodorization of the exhaust air prior to discharge. Investigations should also be made of modifications to up-date the existing power distribution systems and to improve preventive

maintenance facilities and housekeeping. Inclusion of standby power facilities should be investigated.

Chemical Treatment. The space limitations at North Point make it necessary that the chemical treatment alternative be thoroughly investigated. It is recommended that pilot plant studies be carried out with chemical treatment as soon as possible. The most economic dosage of either lime, ferric chloride or alum which satisfies the reduction requirements must be determined and the need for additional treatment after chemical treatment assessed. Recarbonization or other means of returning to acceptable pH levels without additional treatment facilities is very important to the North Point plant and must be thoroughly investigated.

Flotation Treatment. With the expense of effluent pumping involved, the possibility of flotation treatment without primary treatment should be investigated for the North Point plant. As with chemical treatment alternatives, the need for additional treatment after flotation must also be assessed.

Richmond-Sunset Water Pollution Control Plant

Unlike the North Point plant, the Richmond-Sunset plant has practically no land limitation. Although economic considerations still necessitate the full utilization of all existing facilities, considerable attention should be given to physical and biological treatment which do not increase the solids handling and disposal problems. As with the North Point plant, modifying of the existing plant facilities, including the construction of a new ocean outfall, should be the first alternative investigated. Other alternatives to be investigated should include chemical treatment, both with and without micro-straining, filtration and carbon adsorption and flotation; flotation with and without primary sedimentation and chemical pretreatment; and biological treatment.

In all discussions relating to improvement of the Richmond-Sunset plant, it is assumed that the outfall improvements recommended in the separate submarine outfall study will be constructed.

Existing Plant Modifications. To improve the efficiency and reliability of the Richmond-Sunset plant, the following modifications should be investigated:

1. Remodeling of plant influent structures to assure that the plant is operating at its hydraulic capacity before sewage is bypassed, that the velocity of flow through the bar screens is held within optimum limits, and that flow is divided equally between the aerated grit removal tanks in service.
2. Providing postchlorination facilities upstream of the bar screens.
3. Elimination of free fall overflow weirs at discharge of aerated grit removal tanks.
4. Remodeling sedimentation tanks by providing new scum skimming and collection equipment and new submerged effluent collection launders with effluent control gates and sedimentation tank level control system. This includes providing sedimentation tank 5 with new cross collection channel and new longitudinal collectors.
5. Elimination of existing raw sludge and scum removal, thickening, and pumping systems by providing new solids handling gallery under the sedimentation tank cross collector channels. The gallery would house raw sludge and scum pumps of the progressive cavity positive displacement type. Raw sludge pumps would be variable speed with control based on sludge density and the sludge blanket level in the tanks. Pumps would discharge directly to primary digester, with the raw sludge mixed with digester circulating sludge prior to discharge to the digester.
6. Elimination of postchlorination mixing system by utilization of effluent control valve turbulence for rapid mix and new outfall for contact chamber. This includes elimination of the effluent free fall into the Mile Rock sewer.
7. Remodeling of existing solids handling system by providing floating covers for both digesters, eliminating elutriation tanks, renovating filters and all filter auxiliary systems, and changing gas handling system. This includes extension of a new utility tunnel from the new sedimentation tank gallery to the administration building and from the administration building to the digester control building.

Although odor control may not seem as critical at the Richmond-Sunset plant as it is at the North Point plant, it should not be ignored. Complaints of odors from the plant have already been received. Consequently, modifications to the Richmond-Sunset plant ventilation and odor control systems should be investigated. Sewage turbulence and agitation should be eliminated. Critical areas should be isolated and ventilated by a special exhaust system with deodorization of the exhaust air. Investigations should also be made of modifications to up-date the existing power distribution systems and to improve preventive maintenamce facilities and housekeeping. Inclusion of standby power facilities should be investigated.

Chemical Treatment. While economic considerations make it necessary to investigate the alternative of chemical treatment for the Richmond-Sunset plant, it should be done fully recognizing the problems which may result in the solids handling and disposal systems. The dosage determinations needed for additional treatment and recarbonation studies should parallel those indicated for the North Point plant. Effects of the solids handling and disposal systems should be thoroughly investigated.

Flotation Treatment. An investigation of the possible applications of flotation treatment both with and without primary sedimentation should be made. If this type of treatment can provide the necessary reductions in grease, turbidity and floatables, it will provide a reasonable alternative for the Richmond-Sunset plant since extensive changes to the solids handling and disposal system will not be required. If flotation alone cannot produce an effluent meeting the reduction requirements, additional treatment by micro-straining, filtration, carbon adsorption and chemical pretreatment should also be assessed.

Biological Treatment. Richmond-Sunset sewage should be amenable to treatment by biological means. This has already been proven to be the case for the 1.0 mgd Golden Gate Park activated sludge water reclamation plant which has operated for over 38 years on sewage from the Richmond-Sunset system.

Southeast Water Pollution Control

Because the Southeast plant serves the major industrial areas of the city and receives a major portion of the solids from the North Point plant, alternative investigations will differ somewhat from the other two plants. Like the others, modification of existing plant facilities, including an overhaul of the solids handling and disposal system and strengthening of the existing outfall, should be the first alternative investigated. Chemical treatment, flotation treatment and biological treatment are all alternatives which should be assessed. If chemical treatment proves most feasible for the North Point plant, the North Point solids which arrive at the Southeast plant will contain the chemical solids resulting from that process. If the Southeast's solids handling and disposal systems must be designed to handle this waste, chemical treatment at the Southeast plant is a more attractive alternative.

Existing Plant Modifications. To improve efficiency and reliability, the following modifications to the existing plant should be investigated:

1. Elimination of mechanical bar screens from area immediately upstream of raw sewage pumps, elimination of raw sewage sumps and provision of automatic influent level control system for pump and influent gate control.
2. Remodeling of existing grit removal tanks to include provisions for new pump discharge isolation gates, four new machanical bar screens, enlarged grit tanks with new submerged outlet control gates and automatic level control system, and new screenings and grit handling and disposal system.
3. Remodeling of two remaining original sedimentation tanks to utilize mid-tank cross collector and new raw sludge pumping stations alongside each tank. This includes revisions necessary to eliminate influent turbulence and assure equal distribution of flows to tanks in service and new spargers for existing preaeration diffusers.
4. Remodeling of all preaeration-sedimentation tanks by providing new continuous scum skimming and collection equipment and new submerged effluent collection launders with effluent control gates and a sedimentation tank level control system.

5. Elimination of existing raw sludge and scum removal, thickening and pumping systems by providing new raw sludge and scum pumps of the progressive cavity positive displacement type. Raw sludge pumps would be variable speed with control based on sludge density and sludge blanket level in the cross collector hopper. Pumps would discharge directly to primary digesters, with raw sludge mixed with digester circulating sludge prior to discharge to the digesters.

6. Elimination of existing postchlorination diffusion and mixing facilities by utilization of effluent control valve submerged turbulence for rapid mix and effluent sewer, effluent pump station and outfall for contact chamber.

7. Remodeling of effluent pump station and outfall to allow 1 to 1 dilution at all flows up to and including 70 mgd.

8. Remodeling of solids thickening tanks by the construction of new facilities exclusively for North Point solids and separate treatment facilities for thickening tank overflow.

9. Remodeling of digesters and digester controls to bring all ten digesters to the solids handling capability of the three now in primary service, including gas mixing, external heating, and separate sludge circulating and removal pumping facilities. This also includes cleaning out all presently clogged digesters and the design of an automatic system to permit equalizing the load to digesters in service.

10. Remodeling of solid disposal system by eliminating all elutriation facilities and providing existing filters with improved chemical and solids feed controls, solids disposal equipment and filtrate and filter wash water treatment facilities.

11. Construction of new solids incineration facilities for disposal of all solids waste from North Point and Southeast plants, including screenings, grit, scum and filtered sludge.

Even in the industrial neighborhood of the Southeast plant sewage treatment odors can be considered undesirable. Modifications to the Southeast plant ventilation and odor control systems should therefore be thoroughly investigated. All sewage turbulence and agitation should be eliminated. Critical areas should be isolated and ventilated by a special exhaust system with deodorization of exhaust air prior to discharge. As in the other plants, investigations should also be made of modifications to up-date the existing power distribution systems and to improve preventive maintenance facilities and housekeeping. Inclusion of standby power facilities should be investigated.

Chemical Treatment. Chemical treatment appears to be an attractive alternative for the Southeast plant because of its stability in treating industrial wastes. Chemical treatment alternatives should be investigated with dosage determinations, need for additional treatment and recarbonation studies paralleling those indicated for the other two plants. As with the Richmond-Sunset plant, the effect of such treatment on solids loadings and solids handling and disposal systems should be carefully assessed.

Flotation Treatment. Flotation treatment does not appear to be capable of producing an effluent which will conform to the grease requirements stipulated by the Regional Board. Because of the high grease content in the plant influent, additional treatment beyond flotation will undoubtedly be required to attain the necessary reduction in grease content. These alternatives should be investigated, however, even though complete attainment of all requirements with this type of treatment is somewhat doubtful.

Biological Treatment. Both land and hydraulic head are available to incorporate a biological treatment facility after the existing primary sedimentation facilities at the Southeast plant. Industrial wastes can be extremely toxic to such a process, however, and investigations should consider utilizing a biological process which can be buffered from such toxicity.

Summary

It is recommended that each of the three treatment plants be investigated for the application of the following three alternatives: (1) existing plant modifications; (2) chemical

treatment. and (3) flotation treatment. In addition, the Richmond-Sunset and Southeast plants should also be investigated for the application of the biological treatment alternative. Pilot plant studies should be carried out on the many alternatives involved in chemical treatment and the several involved in flotation treatment. Initial pilot plant studies should be made on the chemical treatment alternatives at the North Point plant as soon as possible.

APPENDIX A

ABBREVIATIONS

Appendix A

Abbreviations

Abbreviations to be found in this report are listed below in order of their first use:

%	percent
mg/square meter	milligrams per square meter
mg/l	milligrams per liter
ml/l/hr	milliliters per liter per hour
WPRD	Water Pollution Research and Demonstration
FWQA	Federal Water Quality Administration
JTU	Jackson turbidity units
mgd	million gallons per day
mg/sq m	milligrams per square meter
pH	hydrogen ion concentration
BOD	biochemical oxygen demand (5-day, 20 C)
C	degrees Celsius (formerly centigrade)

APPENDIX B

NORTH POINT WATER POLLUTION CONTROL PLANT

TURBIDITY DILUTION IN RECEIVING WATER

APPENDIX B

Turbidity Values for Known Dilutions of North Point Sewage Effluent in San Francisco Bay Water

S. F. Bay Water sample taken 10/11/70, 1150, near Blossom Rock
North Point Effluent sample taken 10/13/70, 1000

Sample	Concentration	Turbidity
Bay Water		1.6
Effluent	1.000	14
1:1*	0.500	8
2:1	0.333	6.0
4:1	0.200	3.7
8:1	0.112	3.1
16:1	0.059	2.8
32:1	0.030	2.0
64:1	0.015	1.8

A low value, chemical treatment with $FeCl_2$ was in process when sample was taken.

*Bay Water: Effluent

Other measured values of North Point effluent turbidities:

	Influent JTU	Effluent JTU
July 30	64	55
31	57	58
Aug 1	52	48
2	49	43
3	54	55
4	52	53
5	46	53

See plot of tabulated values on Fig. B1.

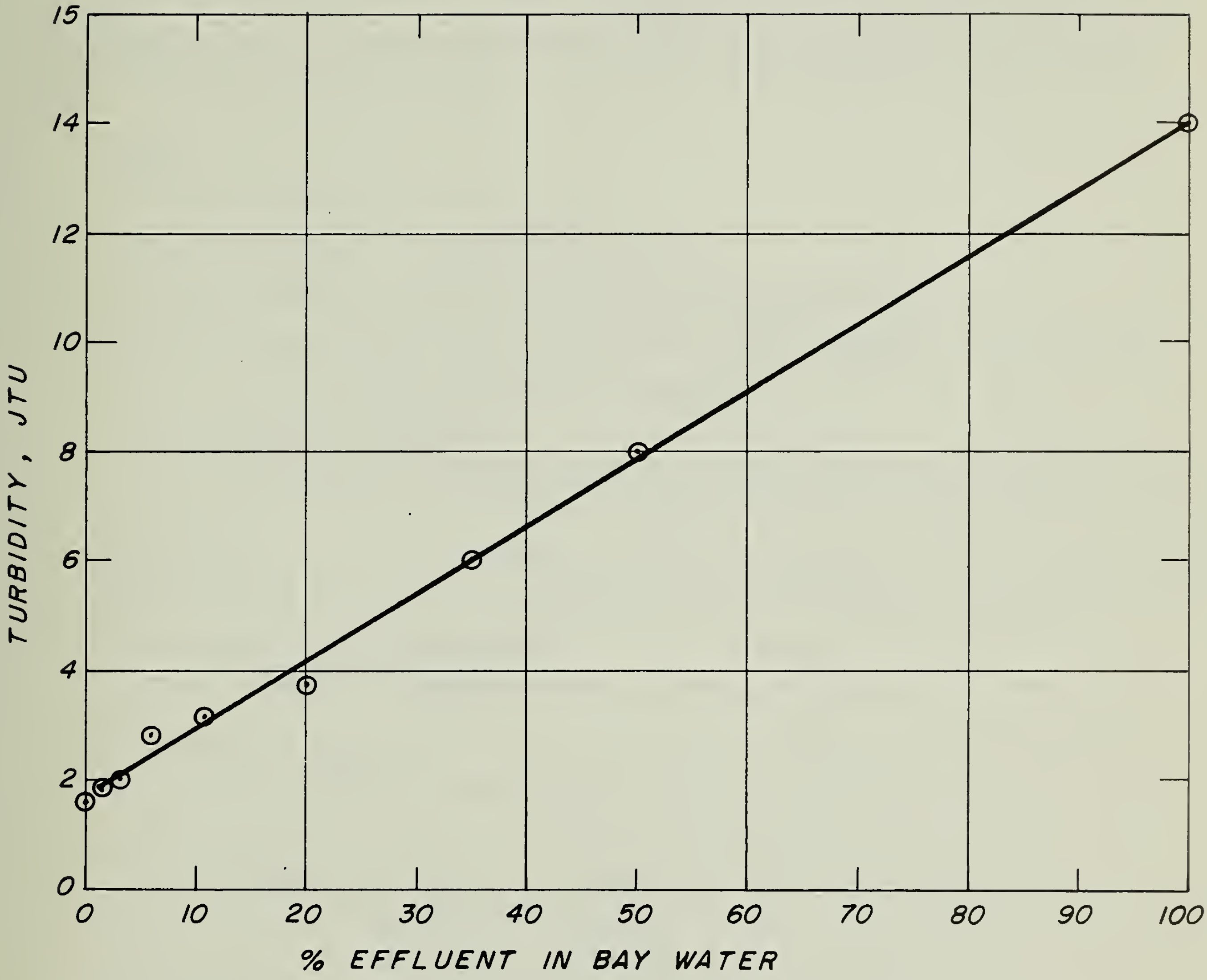


Fig. B1. Turbidity vs. Effluent Dilutions

MEMO from R. T. COCKBURN, MARCH 29, 1971

Brown and Caldwell have reported that the turbidity of a mixture of sewage and bay water varies directly with the percent of sewage in the mixture (see Fig. Bl). If this is the case, then it is possible to evaluate the relationships between any receiving water, effluent and dilution to obtain the reduction in clarity as measured as an increase in turbidity in the receiving water dilution zone.

terms:

T_e = turbidity of effluent, JTU

T_r = turbidity of receiving water, JTU

T_m = turbidity of mixed waste and receiving water, JTU

D = dilution ratio, parts bay water to parts effluent, e.g. X:Y where X = receiving water and Y = effluent

W = % waste in mixture

I = % increase in mixture turbidity divided by 100, e.g. 5%/100 = 0.05

for dilution ratio D, Y will always be 1, e.g. as 100:1 $\therefore$ D = X numerically and

$W = Y/x+y \cdot 100$ (equation 1)

$D = X = \frac{100Y}{W} - Y$ (equation 2)

by def Y = 1

$\therefore D = X = \frac{100}{W} - 1$ (equation 3)

example:	D = 1:1	W = 50%
	D = 9:1	W = 10%
	D = 100:1	W $\cong$ 1%(-)

if relationship as noted in Fib. Bl is linear then:

form $y = mx+b$

where $Y = T_m$

$X = W$

m = slope

b = constant

boundary conditions: $T_m = mW+b$

$W = 0$

$$T_m = b = T_r$$

$W = 100\%$

$$T_m = mW + T_r = T_e \quad \text{(equation 4)}$$

$$\therefore m = \frac{T_e - T_r}{W} \text{ where } W = 100\%$$

$$\therefore m = \frac{T_e - T_r}{100}$$

$$\therefore T_m = \frac{T_e - T_r}{100} \cdot W + T_r \quad \text{(equation 5)}$$

$$D = \frac{100}{W} - 1 \text{ , } D+1 = \frac{100}{W} \text{ , \& } W = \frac{100}{D+1}$$

$\therefore$ in terms of D

$$T_m = \frac{T_e - T_r}{100} \cdot \frac{100}{D+1} + T_r = \frac{T_e - T_r}{D+1} + T_r \quad \text{(equation 6)}$$

in terms of % increase in turbid. of mixture

$$T_m = (1+I)T_r \quad \text{(equation 7)}$$

$$\therefore T_r(1+I) = \frac{T_e - T_r}{D+1} + T_r$$

$$1+I = \frac{T_e - T_r}{T_r(D+1)} + 1$$

$$I = \frac{T_e - T_r}{T_r(D+1)}$$

$$I \cdot T_r(D+1) = T_e - T_r$$

$$IT_rD + IT_r = T_e - T_r$$

$$T_rID + T_rI + T_r = T_e$$

$$T_r(ID+I+1) = T_e$$

$$ID+I+1 = T_e/T_r$$

$$\therefore I(D+1) = \frac{T_e}{T_r} - 1 \quad \text{(equation 8)}$$

$$\text{or} \quad D = \frac{1}{I}\left({}^{T}e/T_r - 1\right) - 1 \quad \text{(equation 9)}$$

$\therefore$ knowing the dilution D, the receiving water and effluent turbidities T_e, T_r the % reduction 100I can be determined, etc.

This family is shown in Figs. B2 and B3.

Utilizing this set of curves and knowing any two of the three parameters the third can be determined readily.

Example:

SEWPCP: using dilution contours developed for the toxicity monitoring and the effluent turbidity as measured together with the background receiving water turbidity, the % increase in turbidity for each contour can be readily determined.

See Fig. B4.

background turbidity is 2.8 JTU

effluent turbidity is 100 JTU

$$T_e/T_r = \frac{100}{2.8} \cong 36$$

min. dilution $\cong$ 50:1 $\therefore$ % increase in turbidity is about 70+%

If the pumps would allow a 100:1 dilution via 2:1 predilution, then the reduction would be about 35% wer. m turbidity & a 115:1 dilution would be required to obtain the 30% increase in turbidity which is the upper goal of the Board.

Conversely, assuming that 100:1 is the best possible dilution attainable and that a 5: increase is the goal then T_e/T_r = 6 or 1/6 of the value now existing.

the effluent must be 17 JTU or less, an 83% reduction from the existing effluent JTU of 100.

RTC
3/23/71

Note: these also apply to any other constit. that behaves in a similar fashion; note where T_m is lower than T_r, I is negative in value.

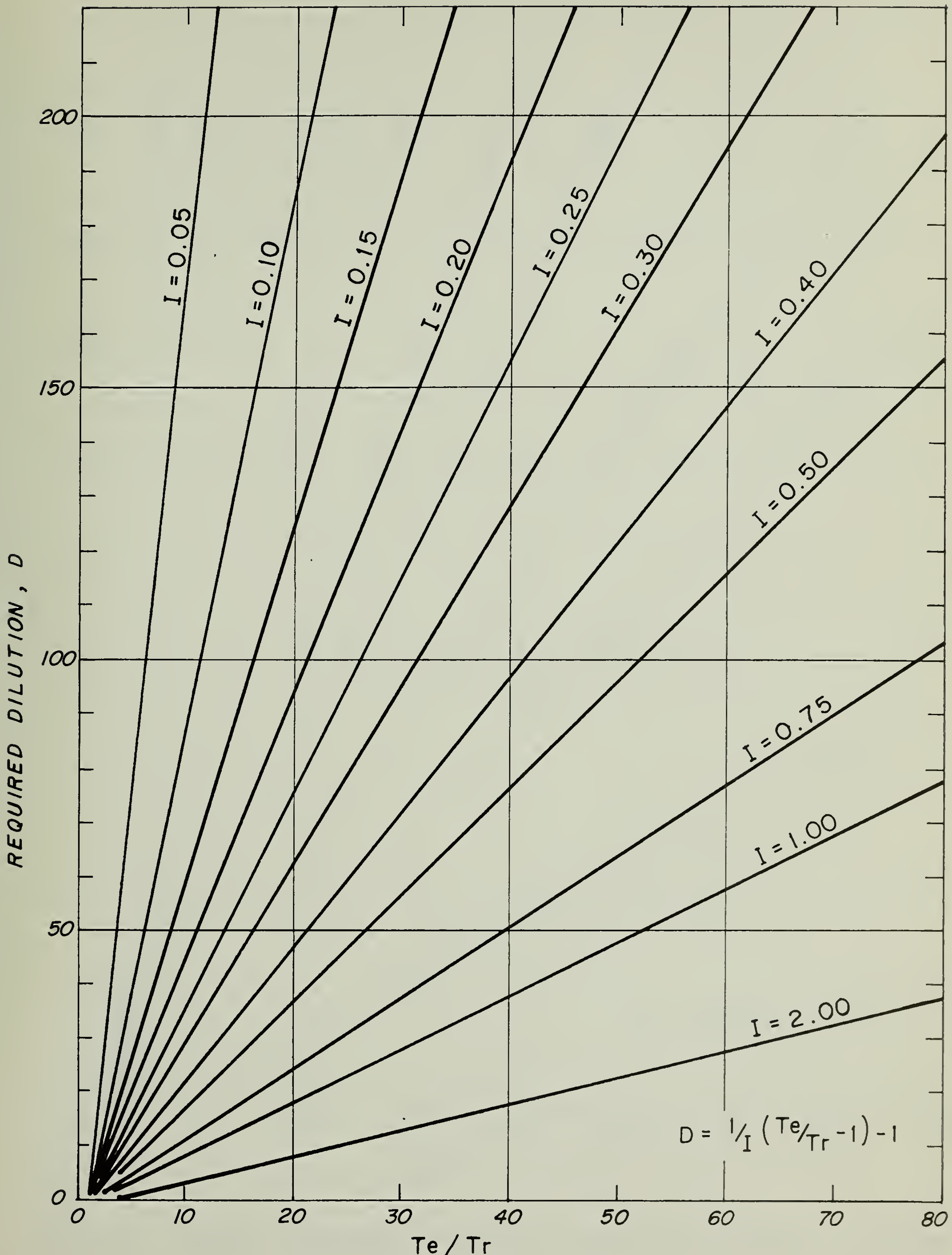


Fig. B2. Ratio: Effluent Turbidity/Receiving Water Turbidity

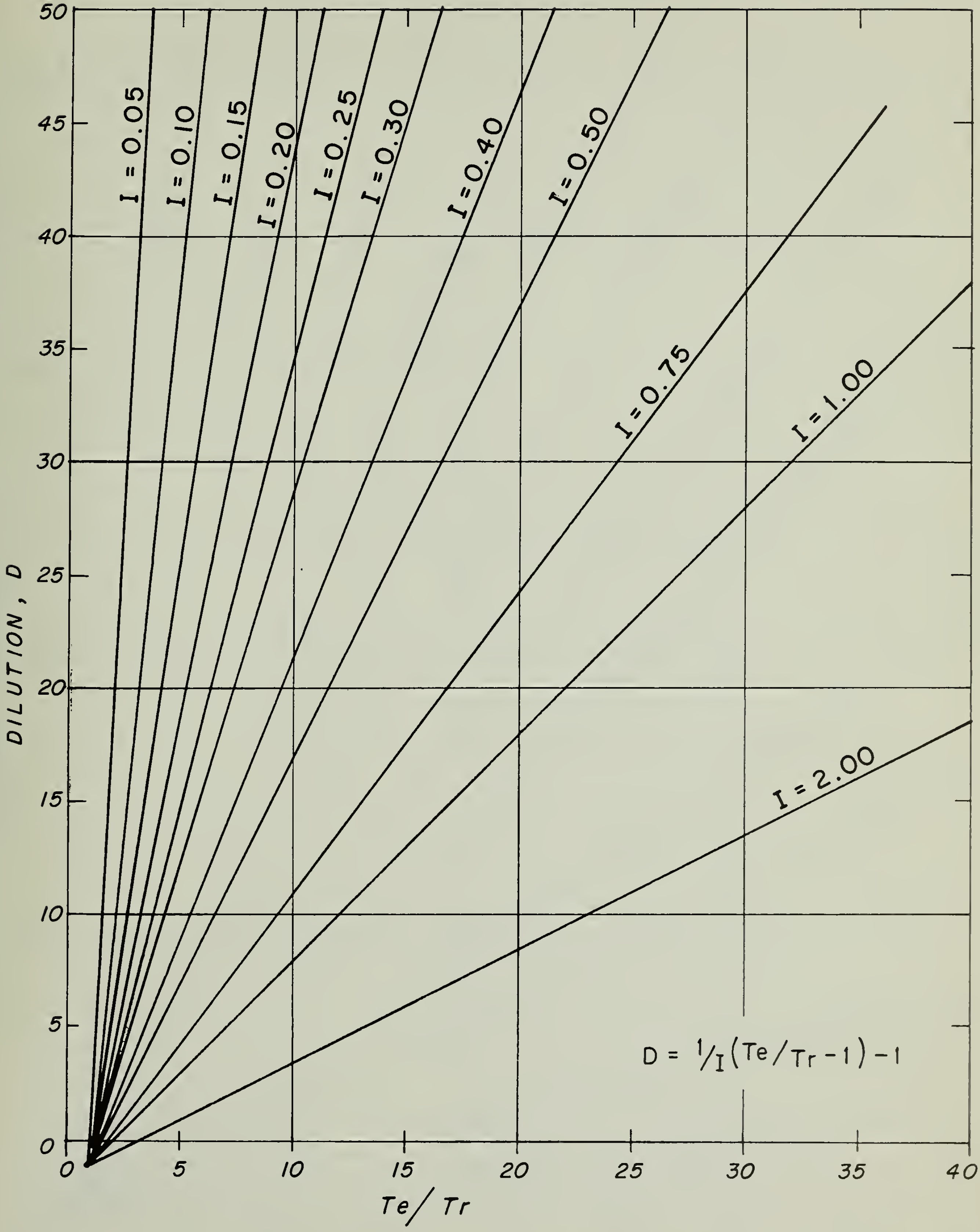


Fig. B3. Ratio: Effluent Turbidity/Receiving Water Turbidity

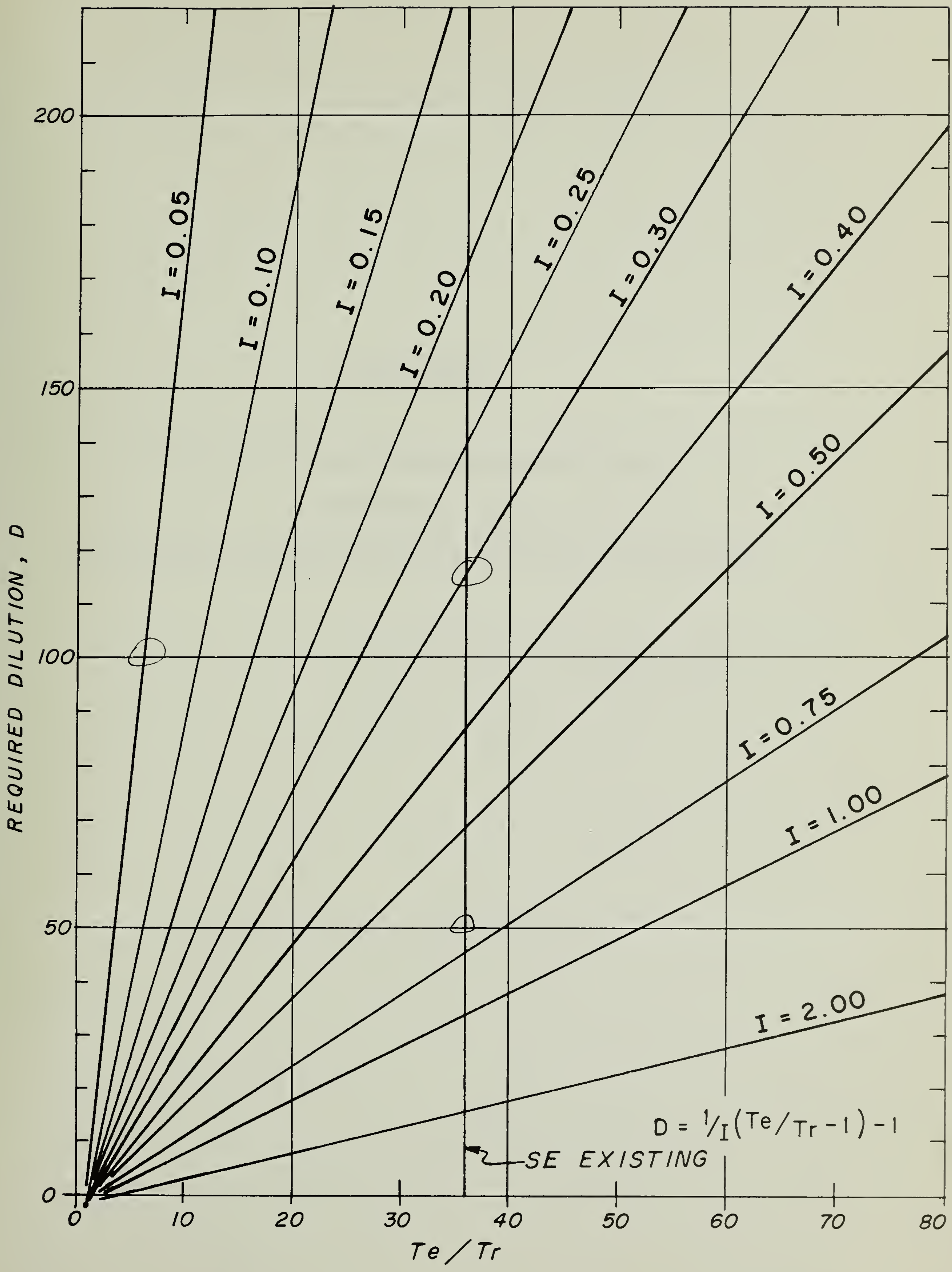


Fig. B4. Ratio: Effluent Turbidity/Receiving Water Turbidity

APPENDIX C1

NORTH POINT WATER POLLUTION CONTROL PLANT

RESOLUTION NO. 70-17

SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

RESOLUTION NO. 70-17

PRESCRIBING REVISED REQUIREMENTS FOR WASTE DISCHARGE BY THE CITY AND COUNTY OF SAN FRANCISCO FROM ITS NORTH POINT SEWAGE TREATMENT PLANT AND RESCINDING RESOLUTION NO. 69-43

WHEREAS THIS REGIONAL BOARD HAS CONSIDERED

INFORMATION ABOUT THIS DISCHARGE

1. This Regional Board adopted Resolution No. 69-43 in September 1969 to prescribe requirements for this discharge.

2. Information submitted by the City and County of San Francisco, referred to as the discharger below, and by others, provides the data itemized below and other data included in a staff report reviewed by this Board in considering this matter:

   The discharger's North Point sewerage system has been designed to transport all sewage and industrial wastes plus storm water resulting from up to 0.02 inch per hour of rainfall to the North Point Plant for primary treatment. The present average dry-weather flow at the plant is 57.1 million gallons per day (mgd) from a population of 813,000 persons. The plant has a design capacity of 97.6 mgd and a rated maximum hydraulic capacity of 190 mgd.

   The waste is discharged through four forty-eight-inch diameter outfalls which terminate 800 feet offshore, two at the end of Pier 33 and two at Pier 35. The discharges are submerged at a depth of ten feet below mean lower low water.

3. This Board has adopted policy guidance with respect to the receiving waters affected by these wastes with its Resolutions Nos. 803, 67-1 and 67-30.

STAFF INVESTIGATION

1. These wastes can affect the following beneficial uses of the San Francisco Bay and contiguous waters:

   Industrial cooling water in the vicinity of the Pacific Gas and Electric Company's (P.G.&E.) generating plants at Potrero and Hunters Points.

   Swimming, wading, pleasure boating, marinas, launching ramps, fishing and shellfishing.

Firefighting and industrial washdown.

Fish, shellfish and wildlife propagation and sustenance and waterfowl and migratory bird habitat and resting.

Navigation channels and port facilities.

Esthetic appeal.

2. Land uses within 1,000 feet of the discharge include port facilities and transportation.

RESOLVED BY THIS REGIONAL BOARD

BOARD INTENT

1. Protect public health as it may be affected by these waste discharges.

2. Prevent nuisance, as defined in Section 13050(m) of the California Water Code.

3. Protect the beneficial water uses listed under "Staff Investigation", above.

   In accordance with Section XVII of its Resolution No. 803, this Board has received a report from the Department of Fish and Game dated August 26, 1968 which describes beds suitable for shellfishing that are located along the Bayshore, south of Candlestick Point, along the shore of Alameda County and in Richardson Bay, Marin County. This Board will consider the matter of protecting these beds for the taking of shellfish for human consumption after it has reviewed a report to be submitted by the State Department of Public Health in accordance with Resolution No. 803.

4. To amend Resolution No. 69-43 to make the code references consistent with the Porter-Cologne Water Quality Control Act which became operative on January 1, 1970 without making any substantive changes in the specific requirements contained therein.

WASTE DISCHARGE REQUIREMENTS - RECEIVING WATERS

1. The treatment or disposal of waste shall not create a nuisance as defined in Section 13050(m) of the California Water Code.

2. The discharge shall not:

   a. Unreasonably affect any of the protected beneficial water uses resulting from:

      Floating, suspended, or deposited macroscopic particulate matter, or foam in waters of the State at any place;

Bottom deposits at any place;

Aquatic growths at any place;

Alteration of temperature, turbidity or apparent color beyond present natural background levels in waters of the State at any place.

b. Cause visible, floating, suspended or deposited oil or other products of petroleum origin in waters of the State at any place.

3. Waters of the State to exceed the following limit of quality at any place within one foot of the surface at any time:

Dissolved Oxygen	5.0 mg/1 minimum
Dissolved Sulfides	0.1 mg/1 maximum
pH	7.0 minimum 8.5 maximum
Coliform Organisms	240 MPN/100 ml, median of five consecutive samples, maximum 10,000 MPN/100 ml, any single sample, maximum Whenever either of these bacterial values is exceeded in the receiving water for any reason they shall both be met instead in the waste at some point in the treatment process. The discharger may demonstrate compliance in the waste stream as an optional alternative. The Board will accept proof of effective effluent disinfection in terms of factors other than bacterial concentrations if the discharger documents a sound statistical correlation between such factors and bacterial analysis, and provided the conditions of sewage strength and treatment do not change from the demonstration period.
Nutrients	to be prescribed at the earliest practicable date.

Other substances	any one or more substances in concentrations that impair any of the protected beneficial water uses or make aquatic life or wildlife unfit or unpalatable for consumption.

WASTE DISCHARGE REQUIREMENTS - WASTE STREAM

The waste stream discharged to waters of the State shall meet these quality limits at all times:

1. In any grab sample:

Settleable matter

The arithmetic average of any six or more samples collected on any day	0.5 ml/l/hr maximum
80% of all individual samples collected during maximum daily flow over any 30-day period	0.4 ml/l/hr. maximum

At this time this Board considers the above two settleable matter limits to be goals rather than requirements.

Any sample	1.0 ml/l/hr. maximum

2. In any representative 24-hour composite sample:

Toxicity: the concentration of the waste itself at any place within one foot of the surface of the receiving waters	10% of the 96-hour TL_m concentration of the waste as discharged, maximum

3. 5-day, 20°C B.O.D. - Whenever the receiving water dissolved oxygen (DO) concentration prescribed above is not met, the B.O.D. removal from the waste, as demonstrated by analyses of 24-hour composite samples of influent and effluent, shall be increased sufficiently to maintain said DO concentration, but B.O.D. removal during any 21 or more days is not required to exceed:

Average	90%
Not more than two consecutive daily determinations shall indicate B.O.D. removals less than	80%

REPORTING REQUIREMENTS

This Resolution includes items numbered 1, 2, 3, 4, 5, 6, and 7 of the attached "Reporting Requirements", dated January 1, 1970.

NOTIFICATIONS

1. This Board's Resolution No. 69-43 is hereby rescinded.

2. This Board will adopt, prior to December 31, 1970 numerical goals for transparency, floatables, grease and settleable matter as requirements. The Board expects the discharger to report on the type of facilities needed and the cost of complying with various numerical values within the above ranges.

3. This Resolution includes items numbered 1, 2, 3, 4, 5, 6 and 7 of the attached "Notifications", dated January 6, 1970.

WILLIAM C. WEBER
Chairman

March 26, 1970

I, Fred H. Dierker, hereby certify that the foregoing is a true and correct copy of Resolution No. 70-17 adopted by the California Regional Water Quality Control Board - San Francisco Bay Region at its regular meeting on March 26, 1970.

FRED H. DIERKER
Executive Officer
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD -
SAN FRANCISCO BAY REGION

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION
January 1, 1970

REPORTING REQUIREMENTS

1. This Board requires the discharger to file technical reports on self-monitoring work performed according to detailed specifications developed pursuant to the Regional Board's Resolution No. 398. (Reference: Sections 13267(b) and 13268, California Water Code.)

2. This Board requires the discharger to file a written report within 90 days after the average dry-weather waste flow for any month equals or exceeds 80% of the design capacity of his waste treatment and/or disposal facilities. The discharger's senior administrative officer shall sign a letter which transmits that report and certifies that the policy-making body is adequately informed about it. The report shall include:

    Average daily flow for the month, the date on which the instantaneous peak flow occurred, the rate of that peak flow, and the total flow for that day.

    The discharger's best estimate of when the average daily dry-weather flow rate will equal or exceed the design capacity of his facilities.

    The discharger's intended schedule for studies, design, and other steps needed to provide additional capacity for his waste treatment and/or disposal facilities before the waste flow rate equals the capacity of present units. (Reference: Sections 13260, 13267(b) and 13268, California Water Code.)

3. This Board requires the discharger to file a time schedule for engineering studies on facilities needed to comply with the Board's receiving water objective of 5.0 mg/l of dissolved oxygen and/or to file a time schedule for deciding upon the feasibility of participating in regional water quality control systems if he does not meet that dissolved oxygen objective after providing waste treatment facilities which comply with the effluent BOD requirement prescribed elsewhere in this Resolution. (Reference: Sections 13267(b) and 13268, California Water Code.)

4. This Board requires the discharger to file technical reports on studies into correcting violations of the Board's water quality objectives caused by discharging combined storm water and sewage. Specifications for these studies shall be developed pursuant to the Board's Resolution No. 398. (Reference: Sections 13267(b) and 13268, California Water Code.)

5. This Board requires the discharger to file written reports within 15 days after each calendar quarter to include:

   Name of and number of lots in each subdivision for which an application has been received for connection to the sewerage system. Anticipated date of connection of each subdivision to the sewerage system.

   Finding and supporting data by governing body on effect of addition of each subdivision on violation of waste discharge requirements.

   (Reference: Section 11551.6 Business and Professions Code and Sections 13267(b) and 13268, California Water Code.)

6. This Board requires the discharger to file a report on waste discharge at least 120 days before making any material change or proposed change in the character, location or volume of the discharge. (Reference: Sections 13260(b) and 13264, California Water Code.)

7. This Board requires the discharger to file a written technical report at least 15 days prior to advertising for bids on any construction project which would cause or aggravate the discharge of waste in violation of these requirements; said report to describe the nature, costs, and scheduling of all actions necessary to preclude such discharge. In no case should any discharge of sewage bearing wastes be permitted without at least primary treatment and chlorination. (Reference: Sections 13267(b) and 13268, California Water Code.)

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION
January 6, 1970

NOTIFICATIONS

1. This Board requests the discharger to take note of the comments and recommendations contained in all the correspondence the Board has received and considered concerning this matter, and the Executive Officer is directed to transmit copies of that correspondence to the discharger.

2. This Board considers "Waters of the State" as defined in Section 13050(e) of the California Water Code to include waste waters over which the discharger has lost control.

3. The requirements prescribed herein do not authorize the commission of any act causing injury to the property of another, nor protect the discharger from his liabilities under Federal, State, or local laws, nor guarantee the discharger a capacity right in the receiving waters.

4. This Board will prescribe more restrictive requirements for this waste discharge if necessary:

   To achieve or maintain dissolved oxygen concentration of at least 5.0 mg/l in tidal waters of the San Francisco Bay System pursuant to Resolution No. 67-30,

   To protect shellfishing areas which the Board designates pursuant to Resolution No. 803,

   To protect the beneficial water uses, and to achieve other objectives adopted in the resolutions cited above.

5. This Board will review these requirements periodically, as required by law, and will notify the responsible persons before doing so. (Reference: Section 13263(e), California Water Code.)

6. The water quality parameters used in this resolution are as defined in the latest edition of "Standard Methods for the Examination of Water and Wastewater" by the American Public Health Association.

7. The discharger is advised that this Board will use the general concepts of Phase I of the plan recommended by the Final San Francisco Bay-Delta Program Report as guidelines in reviewing any application for construction grants for sewerage facilities proposed to comply with these requirements, and if the discharger intends to make such application he must demonstrate the compatibility of the proposed facilities with the general concepts of the Bay-Delta Program.

APPENDIX C2

RICHMOND SUNSET WATER POLLUTION CONTROL PLANT

RESOLUTION NO. 67-2

SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD

STATE OF CALIFORNIA
REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

RESOLUTION NO. 67-2

PRESCRIBING REQUIREMENTS AS TO THE NATURE OF WASTE DISCHARGE BY THE CITY AND COUNTY OF SAN FRANCISCO-RICHMOND-SUNSET SEWAGE TREATMENT PLANT INTO THE PACIFIC OCEAN, SAN FRANCISCO COUNTY AND RESCINDING RESOLUTION NO. 588

I. WHEREAS, a Report on Waste Discharge, dated January 11, 1963, was filed in accordance with Section 13054 of the State Water Code with this Regional Water Quality Control Board by the City and County of San Francisco, hereinafter referred to as the Discharger, on January 14, 1963; and

II. WHEREAS, said report and other data submitted by the discharger provide the following information:

A. The waste is being discharged from the Richmond-Sunset Drainage Zone sewerage system of the City and County of San Francisco at the following locations:

1. The Mile Rock Tunnel - a 9 by 11 foot tunnel which discharges directly into the Pacific Ocean at the base of a cliff in Lincoln Park in line with a prolongation of Forty-Eighth Avenue

2. A concrete structure through which two diversion sewers (6.5 and 5.0 feet diameter) and Lobos Creek discharge onto Baker's Beach

3. An 18 inch pipe which discharges onto Baker's Beach from the Seacliff Pumping Station No. 2

4. A 6 foot diameter pipe which discharges into the Pacific Ocean at the base of a cliff at the foot of Twenty-Seventh Avenue

5. A 12 inch diameter pipe which discharges from Seacliff Pumping Station No. 1 onto Phelan Beach adjacent to a public bath house

6. An outfall with three 6 foot square compartments which discharges onto Ocean Beach at the foot of Lincoln Way

7. Two 5 foot diameter pipes which discharge onto Ocean Beach at the foot of Vicente Street

8. A 10 by 11 foot tunnel which discharges onto a public beach adjacent to the Vista Grande Tunnel;

B. The discharge from the Mile Rock Tunnel consists of treated effluent during dry weather; of mixed effluent and raw sewage when the Sunset lift station is overloaded or there is a malfunction in the Richmond-Sunset plant and of mixed effluent, raw sewage and storm water during wet weather;

C. The discharge from outfall number 2 above consists of runoff from Lobos Creek during dry weather; storm water and Creek water when there is a malfunction and of mixed raw sewage, storm water and Creek water during wet weather;

D. The discharges from outfalls numbers 3 through 8 above consist of ground water seepage during dry weather; of mixed raw sewage and seepage when there is a malfunction and of raw sewage and storm water during wet weather;

E. The waste flow to the Richmond-Sunset Sewage Treatment Plant is reported as follows:

1. Average dry weather:

Present flow	16 million gallons per day
Design flow	22.5 million gallons per day

2. Wet weather flow for 54 days during the months of January through April and August through December 1962:

Average	17.9 million gallons per day
Maximum	30(a) million gallons per day

(a) Maximum capacity of flow recorder

3. Maximum plant capacity 70.0 million gallons per day;

F. The population served is estimated as follows:

1. Present 215,000 persons
2. Design 250,000 persons; and

G. A program has been initiated to study methods for controlling discharges from combined sewers:

1. The City has been awarded a $99,820 grant by the Federal Government for such a study

2. The City has committed $28,880 in manpower and facilities to the study

3. The consulting engineer who conducts the study will be required to submit a final report to the City in July 1967; and

III. WHEREAS, the Board received and considered the following correspondence prior to August 1964 regarding this waste discharge:

A. Memorandum from State Department of Fish and Game, dated May 13, 1963;

B. Memoranda from State Department of Public Health, dated April 24, 1963, May 8, 1964, and December 31, 1965;

C. Memorandum from State Department of Water Resources, dated April 15, 1963;

D. Letters from City and County of San Francisco Department of Public Health, dated April 19, 1963, and April 28, 1964, May 20 and August 6, 1965;

E. Letter from the City and County of San Francisco Recreation and Park Department, dated April 18, 1963;

F. Letter from the City and County of San Francisco Department of Public Works, dated May 9, 1963; and

G. A copy of a report dated August 24, 1965, from the State Department of Public Health to the City and County Department of Public Health entitled:

"Review of Data on Ocean Beaches in the City and County of San Francisco - June 20, 1964, through March 27, 1965"; and

IV. WHEREAS, investigation by the staff of the Board discloses that:

A. Beneficial uses of the waters of the Pacific Ocean include:

1. In the vicinity of each of the discharges described in Section II-A of this Resolution:

a. Aesthetic enjoyment
b. Fish habitat, migration and propagation
c. Sport fishing

2. At Phelan Beach, in addition to those named in 1 above:

a. Swimming
b. Wading

3. At Baker's Beach and along the Ocean beaches to the County line, in addition to those named in 1 above:

a. Wading;

B. Land uses near the waste discharge points include:

1. Picknicking
2. Sunbathing
3. Horseback riding
4. Aesthetic enjoyment;

V. WHEREAS, this Regional Board did at its regular meeting on August 20, 1964, adopt Resolution No. 588 entitled:

"PRESCRIBING REQUIREMENTS AS TO THE NATURE OF WASTE DISCHARGE BY THE CITY AND COUNTY OF SAN FRANCISCO RICHMOND-SUNSET SEWAGE TREATMENT PLANT INTO THE PACIFIC OCEAN, SAN FRANCISCO COUNTY"; now

VI. THEREFORE, BE IT RESOLVED, that this Regional Board hereby rescinds its Resolution No. 588;

VII. BE IT FURTHER RESOLVED, that it is the intention of this Board to:

A. Prevent nuisance, as defined in Water Code Section 13005, from being caused by this waste discharge or by treatment or conveyance of wastes tributary thereto;

B. Make or preserve the waters of the Pacific Ocean suitable for the following beneficial uses at all times:

1. At all places along the Ocean shoreline of the City and County of San Francisco:

   a. Fish propagation and habitat
   b. Sport fishing
   c. Aesthetic enjoyment

2. At all beaches along the Ocean shoreline of the City and County of San Francisco excepting Federally owned beaches on the Presidio, so long as a prohibition against the following beneficial uses is enforced, also excepting beaches within 1500 feet on the Mile Rock discharge:

   a. Swimming and wading, without designating water-contact sports areas within the meaning of Section 7952 of Title 17, California Administrative Code

3. At Kelly Cove, which lies offshore from the Sutro Heights Park, north of Balboa Street extended and south of Seal Rocks:

   a. Surf-boarding - without designating a water-contact sports area within the meaning of Section 7952 of Title 17, California Administrative Code;

C. Prevent hazards to public health;

VIII. BE IT FURTHER RESOLVED, that, in order to fulfill its intentions in the preceding paragraph this Board prescribes the following requirements:

A. No sewage discharged from the Richmond-Sunset sewerage zone shall cause any of the following conditions at any time:

1. Deposited macroscopic particulate material or foam of waste origin at any place

2. Atmospheric odors recognizable as being of waste origin at any place outside the Richmond-Sunset Sewage Treatment Plant

3. Turbidity or discoloration in waters of the State at any place more than 200 feet from the Mile Rock Outfall

4. Dissolved sulfide concentrations greater than 0.1 Mg/L within one foot below the surface of the Pacific Ocean at any place

5. At any place more than 100 feet from the Mile Rock Outfall

Dissolved Oxygen	5.0 Mg/L minimum
pH	6.5 minimum to 8.5 maximum

6. At any place more than 300 feet from the Mile Rock Outfall

Any substance or combination of substances in concentrations deleterious to fish or other aquatic life None

The Regional Board will reconsider the area over which this specification applies when more specific parameters are available

7. Any ocean waters being protected for swimming, wading or surfboarding pursuant to Paragraphs VII-B-2 and 3 above, to exceed those standards prescribed in Sections 7957 and 7958 of Title 17, California Administrative Code;

B. No sewage discharged from the Mile Rock outfall shall cause the receiving waters at the beaches within 1500 feet of that outfall to exceed those standards prescribed in Sections 7957 and 7958 of Title 17, California Administrative Code at any time that the public is not effectively excluded from these beaches;

C. The quality of the waste as determined at the discharge from the Richmond-Sunset Sewage Treatment Plant shall be maintained within the following limits at all times:

1. Any 24-hour composite sample made up of portions collected in proportion to rate of flow at time of collection:

Settleable Matter 0.5 ml/l/hr

2. Any grab sample:

Settleable Matter 1.0 ml/l/hr;

IX. BE IT FURTHER RESOLVED, that pursuant to Section 13054.3 of the California Water Code, this Regional Board prohibits all discharges of sewage onto public beaches or at any point inshore from a line 50 feet, minimum, offshore from the extreme low tide line, which do not comply with Sections 7957 and 7958 of Title 17, California Administrative Code, excepting only the discharge from the Mile Rock Outfall pursuant to Section VIII-B above;

X. BE IT FURTHER RESOLVED, that the City and County of San Francisco is required to submit to this Board, on or before June 15, 1967, a statement describing the City's program of study, planning and construction of facilities needed to comply with those requirements of this Board which are violated by sewage discharges from the City's combined sewerage system in the Richmond-Sunset sewerage zone;

XI. BE IT FURTHER RESOLVED, that the City and County is required to file with this Board, on or before the fifteenth day of the last month in each calendar quarter, reports on its progress toward compliance with this Board's requirements for the Richmond-Sunset Sewerage zone; each

report for the second and fourth calendar quarters shall be accompanied by a duly adopted motion of the Board of Supervisors showing that said body has approved the report and is forwarding the same to the Regional Board;

XII. BE IT FURTHER RESOLVED, that in accordance with Sections 13055 and 13055.1 of the Water Code, the discharger is required to file technical reports on self-monitoring work performed according to detailed specifications developed pursuant to the Regional Board's Resolution No. 398, and that all sample collection and analysis for the purpose of determining compliance with the requirements prescribed in this Resolution shall be performed according to these detailed specifications;

XIII. BE IT FURTHER RESOLVED, that the Executive Officer is directed to transmit to the discharger copies of all correspondence this Board has received and considered relative to this waste discharge, and that the Board requests the discharger to take note of the comments and recommendations contained in said correspondence;

XIV. BE IT FURTHER RESOLVED, that these requirements do not authorize the commission of any act causing injury to the property of another nor protect the discharger from his liabilities under Federal, State, or local laws;

XV. BE IT FURTHER RESOLVED, that none of the requirements prescribed in this Resolution are a guarantee to the discharger of a capacity right in the receiving waters;

XVI. BE IT FURTHER RESOLVED, that if conditions should change materially at some time in the future, it may be necessary to review these requirements, and in such event this Board will take up the matter with the responsible persons at that time;

XVII. BE IT FURTHER RESOLVED, that pursuant to Section 13054, California Water Code, this Regional Board requires the discharger to file a written report with the Board when the average dry-weather effluent flow for any calendar month exceeds 20 mgd; this report shall be accompanied by a duly adopted motion of the Board of Supervisors of the City and County approving said report and said report shall contain at least the following information:

A. Average flow for the month and date, time and volume of instantaneous peak flow during the month, as well as total flow for the calendar day during which said peak occurred;

B. Discharger's best estimate as to when the average dry-weather effluent flow for the maximum month will amount to 22.5 mgd;

C. Discharger's intentions with respect to actions to be taken and the timing of such actions, including engineering studies, etc., to expand existing facilities or to provide new or supplemental facilities before the waste flow volume reaches 22.5 mgd.

GRANT BURTON
Chairman

January 19, 1967

I, John B. Harrison, hereby certify that the foregoing is a true and correct copy of Resolution No. 67-2 as adopted by the Regional Water Quality Control Board of Region No. 2 at its regular meeting on January 19, 1967.

JOHN B. HARRISON, EXECUTIVE OFFICER
REGIONAL WATER QUALITY CONTROL BOARD NO.2

APPENDIX C3

SOUTHEAST WATER POLLUTION CONTROL PLANT

RESOLUTION NO. 69-44

SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD

STATE OF CALIFORNIA
REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

RESOLUTION NO. 69-44

PRESCRIBING REVISED REQUIREMENTS AS TO THE NATURE OF WASTE DISCHARGE BY THE CITY AND COUNTY OF SAN FRANCISCO FROM ITS SOUTHEAST SEWAGE TREATMENT PLANT AND RESCINDING RESOLUTIONS NOS. 125 AND 544

WHEREAS THIS REGIONAL BOARD HAS CONSIDERED

INFORMATION ABOUT THIS DISCHARGE

1. This Regional Board has adopted Resolutions Nos. 125, 544 and 718 in April 1953, February 1964 and January 1966, respectively, to prescribe requirements for this discharge.

2. Information submitted by the City and County of San Francisco referred to as the discharger below, and by others, provides the data itemized below and other data included in a staff report reviewed by this Board in considering this matter:

   The discharger's Southeast sewerage system has been designed to transport all sewage and industrial wastes plus storm water resulting from up to 0.02 inch per hour of rainfall to the Southeast Plant for primary treatment. The present average dry weather flow at the plant is 19.4 million gallons per day (mgd) from a population of 161,000 persons. The plant has a design capacity of 51 mgd.

   The waste is discharged through a multi-port diffuser located on a line parallel to and 550 feet north of Islais Creek. The diffusers are located between 500 and 800 feet offshore and at a depth of 50 feet below mean lower low water.

   There is a bypass from the plant effluent pump station into Islais Creek at a point just west of the Third Street Bridge.

3. This Board has adopted policy guidance with respect to the receiving waters affected by these wastes with its Resolutions Nos. 803, 67-1 and 67-30.

STAFF INVESTIGATION

1. These wastes can affect the following beneficial uses of the Central San Francisco Bay and contiguous waters:

   Industrial cooling water in the vicinity of the Pacific Gas and Electric Company's (P.G. & E.) generating plants at Potrero and Hunters Points.

   Swimming, wading, pleasure boating, marinas, launching ramps, fishing and shellfishing

   Firefighting and industrial washdown

   Fish, shellfish and wildlife propagation and sustenance, and waterfowl and migratory bird habitat and resting

   Navigation channels and port facilities

   Esthetic appeal.

2. Land uses within 1000 feet of the discharge include port facilities.

RESOLVED BY THIS REGIONAL BOARD

BOARD INTENT

1. Protect public health as it may be affected by this waste discharge.

2. Prevent nuisance, as defined in Section 13005 of the California Water Code.

3. Recognize waste disposal, dispersion, and assimilation as economic beneficial water uses which shall be regulated to protect other beneficial water uses.

4. Protect the beneficial water uses listed under "Staff Investigation" above.

   In accordance with Section XVII of its Resolution No. 803, this Board has received a report from the Department of Fish and Game dated August 26, 1968, which describes beds suitable for shellfishing that are located along the Bayshore south of Candlestick Point, along the shore of Alameda County and in Richardson Bay, Marin County.

   This Board will consider the matter of protecting these beds for the taking of shellfish for human consumption after it has reviewed a report to be submitted by the State Department of Public Health in accordance with Resolution No. 803.

WASTE DISCHARGE REQUIREMENTS - RECEIVING WATERS

1. The discharge of the waste shall not cause:

   Atmospheric odors recognizable as being of waste origin at any place outside the discharger's treatment plant.

Unsightliness, nor damage to any of the protected beneficial water uses resulting from:

Floating, suspended, or deposited macroscopic particulate matter, foam, oil, or grease in waters of the State at any place; floating oil shall be considered present if in sufficient quantity to cause iridescence;

Bottom deposits at any place;

Aquatic growths at any place;

Significant variation in temperature beyond natural background levels;

Essentially any visible evidence of the waste attributable to floatables, color or turbidity.

Bacterial concentration in waters of the State at any place within one foot of their surface to exceed the limits prescribed in Section 7958, Title 17, California Administrative Code, at any time; when this bacterial concentration is exceeded in the receiving waters for any reason it shall be met instead in the waste at some point in the treatment process and the discharger may do so as an optional alternate; the Board will accept proof of effective effluent disinfection in terms of factors other than bacterial concentrations if the discharger documents a sound statistical correlation between such factors and bacterial analysis.

2. Waters of the State to exceed the following limit of quality at any place within one foot of the surface at any time:

Dissolved Oxygen	5.0 mg/l minimum
Dissolved Sulfides	0.1 mg/l maximum
pH	7.0 minimum 8.5 maximum

Any one or more substances in concentrations that impair any of the protected beneficial water uses or make aquatic life or wildlife unfit for consumption.

WASTE DISCHARGE REQUIREMENTS - WASTE STREAM

The waste discharged shall meet these quality limits at all times:

1. In any grab sample:

Settleable matter	
The arithmetic average of any six or more samples collected on any day	0.5 ml/l/hr. maximum

80% of all individual samples collected during maximum daily flow over any 30-day period	0.4 ml/l/hr. maximum

At this time this Board considers the above two settleable matter limits to be objectives rather than requirements.

Any sample	1.0 ml/l/hr. maximum

2. In any representative 24-hour composite sample:

Toxicity: the concentration of the waste itself at any place within one foot of the surface of the receiving waters	10% of the 96-hour TL_m concentration of the waste as discharged, maximum

3. 5-day, 20°C B.O.D. - Whenever the receiving water dissolved oxygen (DO) concentration prescribed above is not met, the B.O.D. removal from the waste, as demonstrated by analyses of 24-hour composite samples of influent and effluent, shall be increased sufficiently to maintain said DO concentration, but B.O.D. removal during any 21 or more days is not required to exceed:

Average	90%
Not more than two consecutive daily determinations shall indicate B.O.D. removals less than	80%

OTHER REQUIREMENTS AND CONDITIONS

1. This Resolution rescinds Resolutions Nos. 125 and 544 and supersedes all prior requirements for this discharge.

2. The discharger is required to submit the following reports to this Board on or before November 30, 1969:

   A firm and detailed time schedule for the preparation of a preliminary engineering report and cost estimates for facilities needed to comply with the above requirements for floatables, turbidity, discoloration and settleable matter. For the purposes of said report the discharger shall use the following numerical ranges:

Reduction in receiving water clarity	5 to 30% in 90% of the determinations made on any day in the area of greatest turbidity
Floatables in the receiving water at any place	10 to 50 mg/square meter
Grease in the effluent	5 to 30 mg/l
Settleable matter	Those objectives and requirements listed above.

A firm and detailed time schedule for all investigations necessary to implement a program to minimize all discharges of waste which would not comply with requirements prescribed herein and which would result from equipment or power failure.

(References: Section 13055, California Water Code and this Board's Resolution No. 398)

This Board will adopt, prior to December 31, 1970 numerical objectives for transparency, floatables, grease and settleable matter as requirements. The Board expects the discharger to report on the type of facilities needed and the cost of complying with various numerical values within the above ranges.

3. The discharger is required to submit a written technical report to this Board at least 15 days prior to advertising for bids on any construction project which could cause the discharge of wastes which would not comply with requirements prescribed herein; said report to describe the nature, costs and scheduling of all actions necessary to preclude such discharge(s).

   (Reference: Section 13055, California Water Code)

4. This Resolution includes items numbered 1, 2, 3, 4, 5, 6, 7, 8, 10, and 11 of the attached "Requirements and Conditions" dated October 2, 1968.

WILLIAM C. WEBER
Chairman

September 25, 1969

I, Fred H. Dierker, hereby certify that the foregoing is a true and correct copy of Resolution No. 69-44 adopted by the Regional Water Quality Control Board of Region No. 2 at its regular meeting on September 25, 1969.

FRED H. DIERKER
Executive Officer
REGIONAL WATER QUALITY CONTROL BOARD NO. 2

STATE OF CALIFORNIA
REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

October 2, 1968

REQUIREMENTS AND CONDITIONS

1. This Board requests the discharger to take note of the comments and recommendations contained in all the correspondence the Board has received and considered concerning this matter, and the Executive Officer is directed to transmit copies of that correspondence to the discharger.

2. For the purpose of this Resolution, "Waters of the State" includes waste waters over which the discharger has lost control.

3. The requirements prescribed herein do not authorize the commission of any act causing injury to the property of another, nor protect the discharger from his liabilities under Federal, State, or local laws, nor guarantee the discharger a capacity right in the receiving waters.

4. This Board requires the discharger to file technical reports on self-monitoring work performed according to detailed specifications developed pursuant to the Regional Board's Resolution No. 398. (Reference: Sections 13055 and 13055.1, California Water Code).

5. This Board will prescribe more restrictive requirements for this waste discharge if necessary:

    To achieve or maintain dissolved oxygen concentration of at least 5.0 mg/l in tidal waters of the San Francisco Bay System pursuant to Resolution No. 67-30,

    To protect shellfishing areas which the Board designates pursuant to Resolution No. 803,

    To protect the beneficial water uses, and to achieve other objectives adopted in the resolutions cited above.

6. This Board will review these requirements if necessary because of materially changed conditions, and will notify the responsible persons before doing so (Reference: Sections 13054 and 13054.1, California Water Code).

7. This Board requires the discharger to file a written report within 90 days after the average dry-weather waste flow for any month equals or exceeds 80% of the design capacity of his waste treatment and/or disposal facilities. The discharger's senior administrative officer shall sign a letter which transmits that report and certifies that the policy-making body is adequately informed about it. The report shall include:

Average daily flow for the month, the date on which the instantaneous peak flow occurred, the rate of that peak flow, and the total flow for that day.

The discharger's best estimate of when the average daily dry-weather flow rate will equal or exceed the design capacity of his facilities.

The discharger's intended schedule for studies, design, and other steps needed to provide additional capacity for his waste treatment and/or disposal facilities before the waste flow rate equals the capacity of present units. (Reference: Sections 13054, 13055, and 13055.1, California Water Code).

8. This Board requires the discharger to file a time schedule for engineering studies on facilities needed to comply with the Board's receiving water objective of 5.0 mg/l of dissolved oxygen and/or to file a time schedule for deciding upon the feasibility of participating in regional water quality control systems if he does not meet that dissolved oxygen objective after providing waste treatment facilities which comply with the effluent BOD requirement prescribed elsewhere in this Resolution. (Reference: Sections 13055 and 13055.1, California Water Code).

9. This Board requires the discharger to file a written report on the spatial configuration of the rising plume from his diffuser and the inital dilution of the waste in the receiving waters at the periphery of the plume to aid in determining compliance with certain receiving water requirements. That report shall be based upon actual observations as part of a study for which specifications shall be developed pursuant to the Board's Resolution No. 398. (Reference: Sections 13055 and 13055.1, California Water Code).

10. This Board requires the discharger to file technical reports on studies into correcting violations of the Board's water quality objectives caused by discharging combined storm water and sewage. Specifications for these studies shall be developed pursuant to the Board's Resolution No. 398. (Reference: Sections 13055 and 13055.1, California Water Code).

11. This Board requests the discharger to develop and implement a program to prevent accidental waste spills, and to keep the Board informed of the progress and success of such programs. (Reference: Sections 13052 (a) and (b), California Water Code).

APPENDIX D

NORTH POINT WATER POLLUTION CONTROL PLANT

CONCENTRATION OF FLOATABLES IN RECEIVING WATER

OVER PROPOSED OUTFALL

APPENDIX D

NORTH POINT OUTFALL

Floatables

Consider the concentration of floatables in the receiving water over North Point discharge.

Assumptions:

1. The only "oily materials" discharged at North Point will be hexane extractables.

2. All grease will rise to surface immediately.

Compute distribution at average current velocity. Greatest concentration will occur in the "boil." Consider grease uniformly distributed over the surface (this is conservative, as grease averaged 38 mg/l, and floatables averaged 2.5 mg/l max.).

$Q = 60 \text{ mgd} = 500 \text{ mil lb/day}$

$\text{Grease} = (500)(38) = 19{,}000 \text{ lb/day}$

Assume "boil" has width equal to diffuser length, and a length equal to 15 min. travel at average current of 1.3 K.

$W = 1700 \text{ ft} \qquad L = (6080)(1.3)(0.25) = 2000 \text{ ft}$

$$A = \frac{(1700)(2000)}{3.09^2} = 360{,}000 \text{ m}^2$$

$$\text{Wt. grease} = \frac{19{,}000 \text{ lb/day}}{(4)(24)} = 200 \text{ lb/15 min.}$$

$(200 \text{ lb})(454 \text{ gm/lb}) = 91{,}000 \text{ gm grease/15 min.}$

$$\text{Floatables distrib.} = \frac{91{,}000 \text{ gm}}{3.60 \text{ m}^2} = 0.25 \text{ gm/m}^2$$

If 50 percent of grease rises to surface in first 15 min., floatables will be 0.13 gm/m^2. These levels would be unacceptable by Bay-Delta standard of 0.02 gm/m^2.

However, a study of the basis for establishment of the floatables criterion of 0.02 g/m^2, as presented in Bay-Delta study, shows that it is based on floatables test and not on grease test. Analyze for floatables.

Assumptions:

1. Flow = 83 mgd, 2020 ADWF

2. Floatables conc. - 2.0 mg/l, average for week of 7-30 to 8-5, 1970 in North Point effluent.

APPENDIX D (Cont'd)

North Point Outfall
Floatables

3. Receiving water condition is zero current and zero density difference for jet diffusion.

4. Diffuser is 102-in, 170 3-1/2" ports @ 10' ea. side.

From curve in interim report, dilution when effluent reaches the surface will be 175:1. From computer analysis, the approximate width of field at the surface will be 60 feet. Length of diffuser will be 1700 feet, and area of field <u>at moment of surfacing</u> will be 102,000 $feet^2$.

Field at this time will consist of a turbulent, homogeneous mixture of 1 part effluent and 170 parts sea water.

Assume that floatables will be measured in top 1 inch of field. For 1 m^2, top 1" has vol. of (2.54 cm)(10,000 cm^2) = 25,400 cc, or 25.4 liters.

Original effluent had 2 mg/l of floatables.

$$\underline{\text{Top 1" will have}} \left(\frac{1}{170}\right)\left(2\ \frac{mg}{l}\right)\left(25.4\ \frac{l}{m^2}\right) = \underline{0.3\ mg/m^2}$$

Bay-Delta objective is 20 mg/m^2 <u>OK</u>

<u>Floatables Conc. after 1 Hour</u>

Assumptions:

1. Effluent field disperses horizontally in accordance with the field measurements, $E = 33.0\ L^{4/3}$.

2. Vertical dispersion is zero (surface field remains constant in depth).

3. All <u>floatables</u> rise to surface after 1 hour.

4. The effluent field moves at an average velocity of 1.3 knots.

Computer dispersion analysis for effluent field with initial scale = 1700 feet using Central Bay experimentally determined values of $E = 33.0\ L^{4/3}$ and decay coef. of 4.0 hr. T_{90} for coliform is shown in Fig. D1.

SEWDIF96   16:56 L   09/09/71

VELOCITY= 7920.000 FT/HRDIFFUSER LENGTH= 1700.000 FEET

DIFFUSION LAW COEFFICIENT=   33.0000

MODIFIED DIFFUSION LAW COEFFICIENT=   15.8650

DIFFUSION LAW EXPONENT=   1.3333

BACTERIAL DECAY COEFFICIENT=   0.5750 PER HOUR

COMPUTED SUBSEQUENT DILUTION

TIME,HRS	DISTANCE,FT.	SCALE,FT	DIL RATIO (NO DECAY)	DILUTION RATIO (WITH DECAY)
0.10000	792.	0.1932E+04	0.9986570	0.9428539
0.20000	1584.	0.2174E+04	0.9702146	0.8648165
0.40000	3168.	0.2685E+04	0.8433761	0.6700906
1.00000	7920.	0.4420E+04	0.5295171	0.2979618
2.00000	15840.	0.7887E+04	0.2977926	0.0942921
4.00000	31680.	0.1657E+05	0.1417754	0.0142142
8.00000	63360.	0.3938E+05	0.0596594	0.0005997

PROGRAM STOP AT 630

USED   .82 UNITS

BYE

0000.96 CRU   0000.08 TCH   0001.42 KC

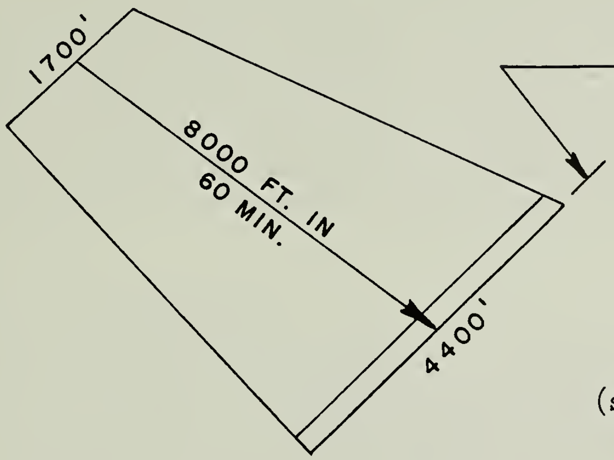
OFF AT 16:57 L 09/09/71

Fig. D1. Computer Dispersion Analysis

APPENDIX D (Cont'd)

North Point Outfall
Floatables

Configuration of effluent field after 1 hour:



(see Pg. D-3)

In 60 minutes the field moves 8000 feet. At the end of 1 hour, all floatables will have risen to the surface. The floatables discharged in one minute will be contained in an area $\left(\frac{8000}{60}\right)\left(4400\right) = 5.9 \times 10^5\ ft^2 = 5.5 \times 10^4\ m^2$

$$\text{Floatables/minute} = \frac{(83\ \text{mgd})(8.34\ \text{lb/gal})(2\ \text{lb/mil lb})}{1440\ \text{min/day}}$$

$$= (0.96\ \text{lb/min})(454) = 440\ \text{grams/min}$$

$$\text{Floatables/m}^2 = \frac{440{,}000\ \text{mg}}{55{,}000\text{m}^2} = 8.0\ \text{mg/m}^2$$

Bay-Delta objective is 20 mg/m^2.

Once all floatables reach the surface, they will continue to disperse, and concentration will be reduced until some steady state valve is achieved at equilibrium with release, transport out of bay, and overlapping effect of all discharges.

Tidal exchange calculations by DSP show that each flood carries about 20% new ocean water past the North Point diffuser site. This means that approximately 100% of water will be new after 5 floods, or 2-1/2 days. We know that surface displacement seaward is more rapid than the average. Surface drift studies show substantially all floatables carried out of bay, with partial deposition found on ocean beaches 4 days later.

APPENDIX D (Cont'd)

North Point Outfall
Floatables

Maximum concentration by above calculations might occur 2 hours after slack when 4.0 mg/m^2 conc. folds back over surfacing 8.0 mg/m^2, giving conc. of 12.0 mg/m^2. Field will continue to disperse for about 5 hours, by which time scale of patch will start to be limited by bay shoreline. Subsequent dispersion will be slower. This is illustrated approximately by the curve Fig. D2. To this concentration must be added the background concentration from North Point and the background concentration from all other dischargers to Central Bay. Calculation of floatables by these assumptions will give values approaching the limiting value of 20 mg/m^2 proposed by Bay-Delta.

Floatables by Field Determination

Engineering Science measured floatables in Baker Street receiving waters (Draft, Chap. VI) in January, February and May, 1969-70. These tests should represent background conditions for North Point plus all other dischargers at present time. Findings as presented in Tables VI-3, VI-4, and VI-5, summarized as follows:

Date	No. of Measurements	Floatables of possible sewage origin, mg/m^2, (1)		
		Avg.	Max.	Min.
2-24-69	2	1.23	1.35	1.11
5-26-69	5	0.20	0.60	0.005
1-10-70	4	0.92	1.52	0.28

(1) Includes all material not identified as non-sewage origin.

Summary

Based on the data available, we can draw the following conclusions:

1. All information on floatables is imprecise at the present time.

2. Calculations for the North Point outfall show that floatables in a surface field may approach, but will not exceed, the Bay-Delta objective of 20 mg/m^2.

3. Field measurements show very low present background conditions for floatables of possible sewage origin, indicating that calculated values are probably conservative.

4. Plans for treatment at North Point should include a contingency plan for more efficient removal of floatables in the event of future need.

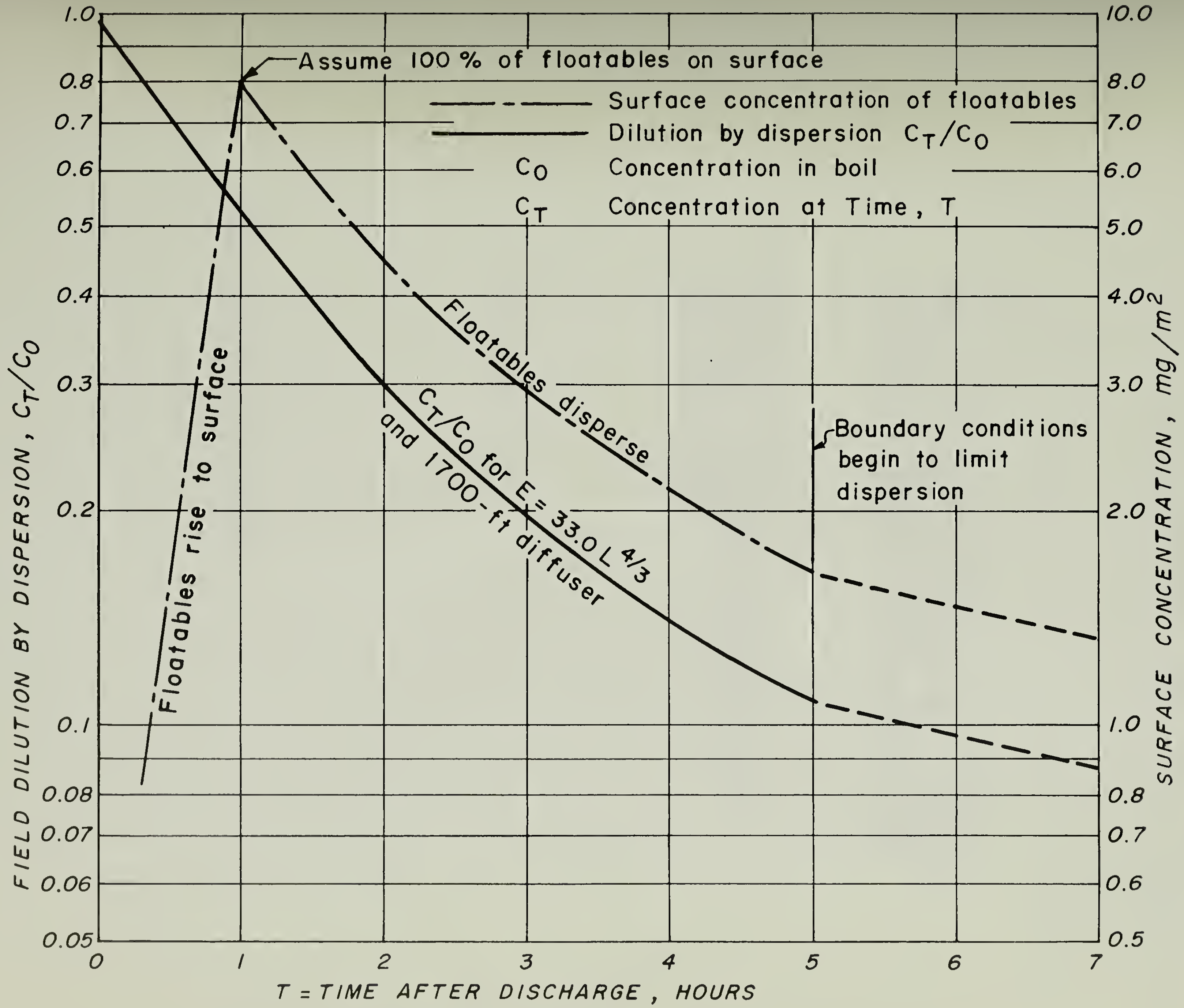


Fig. D2. Surface Dispersion of Floatables

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Phase II

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REPORT ON

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REPORT 2 – PHASE II

ALTERNATIVE TREATMENT PROCESSES FOR REDUCTIONS OF TOXICITY AND BIOSTIMULANTS

SEPTEMBER 1971

BROWN AND CALDWELL
CONSULTING ENGINEERS

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September 1, 1971

F265A

Mr. S.M. Tatarian, Director
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City and County of San Francisco
260 City Hall
San Francisco, CA 94102

WATER POLLUTION CONTROL PLANTS - REPORT 2, PHASE II

In accordance with our agreement dated June 10, 1970, we are submitting Report 2, Phase II on the work covered by our agreement. This report covers alternative treatment processes required to meet various levels of effluent quality with regard to toxicity and biostimulants at the City's three water pollution control plants.

We will be happy to meet with you or your staff to discuss our report at any time you may desire.

BROWN AND CALDWELL

Frank J. Kersnar

Frank J. Kersnar

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CONTENTS

CHAPTER 1

INTRODUCTION

By Resolution Nos. 69-44 and 70-17, the San Francisco Bay Regional Water quality Control Board required the City and County of San Francisco to submit an engineering report on the Southeast and North Point water pollution control plants evaluating the requirements and costs of producing effluents of specified characteristics. These characteristics included receiving water clarity reduction and floatables concentration and effluent grease and settleable matter concentrations.

Although the Regional Board report requirements made no mention of receiving water nutrient, phenol, pesticide or metal concentrations or effluent toxicity, all were generally covered by the waste discharge requirements of Resolution No. 70-17.[1] This resolution states in part:

"WASTE DISCHARGE REQUIREMENTS - RECEIVING WATERS.....

3. Waters of the State to exceed the following limit of quality at any place within one foot of the surface at any time:

...	...
Nutrients	*to be prescribed at the earliest practicable date*
Other substances	*any one or more substances in concentrations that impair any of the protected beneficial water uses or make aquatic life or wildlife unfit or unpalatable for consumption*

WASTE DISCHARGE REQUIREMENTS WASTE STREAM

The waste stream discharged to waters of the State shall meet these quality limits at all times:

...	...

2. In any representative 24-hour composite sample:

Toxicity: the concentration of the waste itself at any place within one foot of the surface of the receiving waters	*10% of the 96-hour TL_m concentration of the waste as discharged, maximum.*

..."

To ascertain its present compliance, its probable future requirements, the type of facilities needed, and the cost of complying with the present and probable future requirements, the City and County of San Francisco, acting through its Department of Public Works, engaged the firm of Brown and Caldwell to prepare the necessary engineering reports evaluating present plant performance and developing improvements necessary to comply with these requirements. All three of the treatment plants were included in this study.

Under the terms of an agreement for engineering services dated June 10, 1970, the required work is divided into two phases. Phase I involves a determination of existing conditions and Phase II involves an evaluation of process and operational changes. Separate reports are required for the two phases.

Objectives and Scope of Phase II Study

The objective of the Phase II study is to evaluate process and operational changes recommended for investigation by Report 3, Phase I and to estimate capital and operating costs at each of the City's three water pollution control plants for facilities required to attain at least four levels of effluent and receiving water quality. At least one or more of these four levels will comply with the anticipated most restrictive requirements and goals of the San Francisco Bay Regional Water Quality Control Board. Under the terms of the agreement for engineering services, work to be performed included the following:

1. Determination of incremental capital and maintenance costs for all process and operational changes.

2. Preparation of a final report for Phase II presenting and discussing information de-

veloped in this phase of the investigation and including a complete description of each alternative for each plant.

Abbreviations used in this report are defined in Appendix B. References are to be found in Appendix C.

Office Work

Office work was concerned with the following principal activities:

1. Determination of alternative treatment processes required for complying with the anticipated objectives, requirements and goals of Regional Board.
2. Determination of estimated construction and operation costs for alternative treatment processes.
3. Preparation of final report.

Progress Reports

Written reports on the progress of the study were made monthly to the Director of Public Works. Additionally, periodic meetings were held with the staff of the Sanitary Engineering Division to discuss the study progress and preliminary findings.

Acknowledgements

For their assistance during the study, we wish to express our appreciation to A. O. Friedland, R. T. Cockburn and W. R. Giessner and other members of the staff of the Division of Sanitary Engineering of the Bureau of Engineering and to K. Fraschina, J. H. Crafts, A. E. Bagot, W. C. Jow, L. T. Yew, R. Loucks, P. Shinn, N. Lago, A. Benas, C. Zern and D. McNulty of the Sewage Treatment Division of the Bureau of Water Pollution Control.

CHAPTER 2

BASIS OF COST ESTIMATES

Development of a reasonable long-range program for improvements to San Francisco's water pollution control plants requires that estimates of comparative costs be prepared for construction of proposed improvements and for the operation of these improvements. To that end, alternatives must be formulated in sufficient detail to determine their capital outlay requirements and the basic operation costs for each type of facility.

CONSTRUCTION COSTS

Construction and operating costs are based on the proposed plant improvements and on the estimated additions to treatment processes required to achieve the goals of the Regional Board. For estimating purposes, prices of comparable work were obtained from available sources of current information.[2,3] Costs of conventional and advanced treatment facilities presented in an article by Robert Smith[4] were used in developing specific cost curves. Manufacturers, suppliers of material and equipment, and local contractors were consulted on specific questions. Costs of wastewater treatment plants designed by Brown and Caldwell were relied upon heavily in developing basic costs. All costs were adjusted as deemed necessary to reflect local San Francisco conditions.

If major improvements to the City's water pollution control plants are undertaken on an accelerated basis, it may be expected that costs will increase correspondingly. Although it is difficult to estimate what the increases for accelerated construction may be, additional costs of 25 percent or more may be incurred. Another factor which will tend to lead to higher construction costs is the requirement that the treatment plants be kept in full operation during construction. Federal guidelines[5], as amended, state that bypassing of untreated or partially treated wastewater during construction will not be permitted.

In considering the estimates, it is important to realize that changes during final design will alter the totals to some degree and that future changes in the cost of material, labor and equipment will cause comparable changes in costs presented herein. On the other hand, since the relative economy of alternative projects can be expected to change only slightly with an increase or decrease in general construction costs, decisions based on present comparisons should remain valid.

Construction costs can be expected to undergo long term changes in keeping with corresponding changes in the national economy. The best available barometer of these changes is the Engineering News-Record construction cost index (ENR index). It is computed from prices of structural steel, portland cement, lumber and common labor, and is based on a value of 100 in the year 1913.

As indicated by the curve on Fig. 5-1, Chapter 5, Report 1, Phase II, which portrays the trend of the ENR index since 1940, nationwide construction costs have been steadily increasing for many years. This figure also shows the rate of increase of the San Francisco area ENR index which reflects the dramatic cost increases attributable to the west coast construction labor agreements of 1965 and 1968 and to recent inflationary trends affecting the cost of materials.

For the purposes of this report, estimated costs are based on an ENR index of 1700, a level which will be reached within the year. The present San Francisco area ENR index is 1687. In any event, costs used herein may be related to those at any time in the past or future by applying the rate of the then prevailing ENR index to 1700.

Construction costs include contractor's overhead and profit, but do not include engineering, construction contingencies, right-of-way, land acquisition ot legal costs. Separate allowances must be made to cover these items. Prices used in preparing preliminary estimates represent average bidding conditions for many

projects. For this reason, it is entirely possible that actual construction bids for a given project may be lower or higher than the estimated cost given herein. Although additive or deductive items are applied where believed necessary to cover special conditions, the preliminary estimates are not presumed to be as accurate as estimates prepared during final design.

Sewage Treatment Processes

Sewage treatment processes include facilities for improving the existing plants; chemical handling, coagulation and flocculation; filtration; dissolved air flotation; activated sludge; effluent pumping; carbon adsorption; gas stripping and oxidation with nitrification and denitrification. Each process provides a unique degree of treatment, sometimes improving many of the vital characteristics and sometimes improving only a few. Final selection of a process combination is usually based on the compatibility, cost and reliable production of an acceptable effluent. Data for estimating construction costs for the above processes with the exception of carbon adsorption, gas stripping and oxidation with nitrification and denitrification are presented in Chapter 5, Report 1, Phase II.

Carbon Adsorption. Construction costs for granulated carbon adsorption process are based on published costs for such treatment. Carbon towers are assumed to operate on at least filtered primary effluent and to be equipped with complete regeneration facilities. Carbon adsorption construction cost curve is plotted on Fig. 2-1.

Gas Stripping. Construction costs for ammonia gas stripping are based on published costs for such treatment. Removal of ammonia is dependent on pH and temperature. Cost figures do not provide for either pH or temperature adjustment. Gas stripping construction cost curve is plotted on Fig. 2-1.

Oxidation with Nitrification and Denitrification. Costs for oxidation with nitrification and denitrification are based on tabulated costs for such treatment. Oxidation with nitrification and denitrification includes nitrifying aeration and sludge aeration tanks with circular intermediate sedimentation tanks and denitrifying anarobic tanks with circular final sedimentation tanks. Nitrifying aeration tanks are assumed to operate on loadings not to exceed 25 lbs applied BOD/1000 cu ft/day. Standby blower and return activated sludge equipment is included. Both intermediate and final sedimentation tanks are assumed to operate at PWWF overflow rates of 2000 gal/sq ft/day. Oxidation with nitrification and denitrification construction cost curve is plotted on Fig. 2-1.

Solids Handling Facilities

Solids handling includes facilities for thickening, conditioning, dewatering and final disposal. Several alternatives are available in each category. For the purposes of cost estimating in this report, only one system for each alternative is used. A complete description, including construction cost, is given in Chapter 5, Report 1, Phase II.

Construction Contingencies

Contingent costs allow for uncertainties unavoidably associated with preliminary design. Such factors as foundation conditions, necessity for special construction methods, unexpected existing conflicts, and critical completion schedules are a few of the many items which may increase contract costs and for which allowances must be made in preliminary design estimates. For contingent items, an allowance of 30 percent is applied to all projects.

Engineering Costs

The cost of engineering services for major construction projects may include special investigations, predesign reports, surveys, foundation explorations, location of interfering utilities, detailed design, preparation of contract drawings and specifications, construction inspection, material testing, final inspection of the completed work and preparation of operation and maintenance manuals. Depending on the size and type of project, total engineering costs for improvements to San Francisco water pollution control plants may range

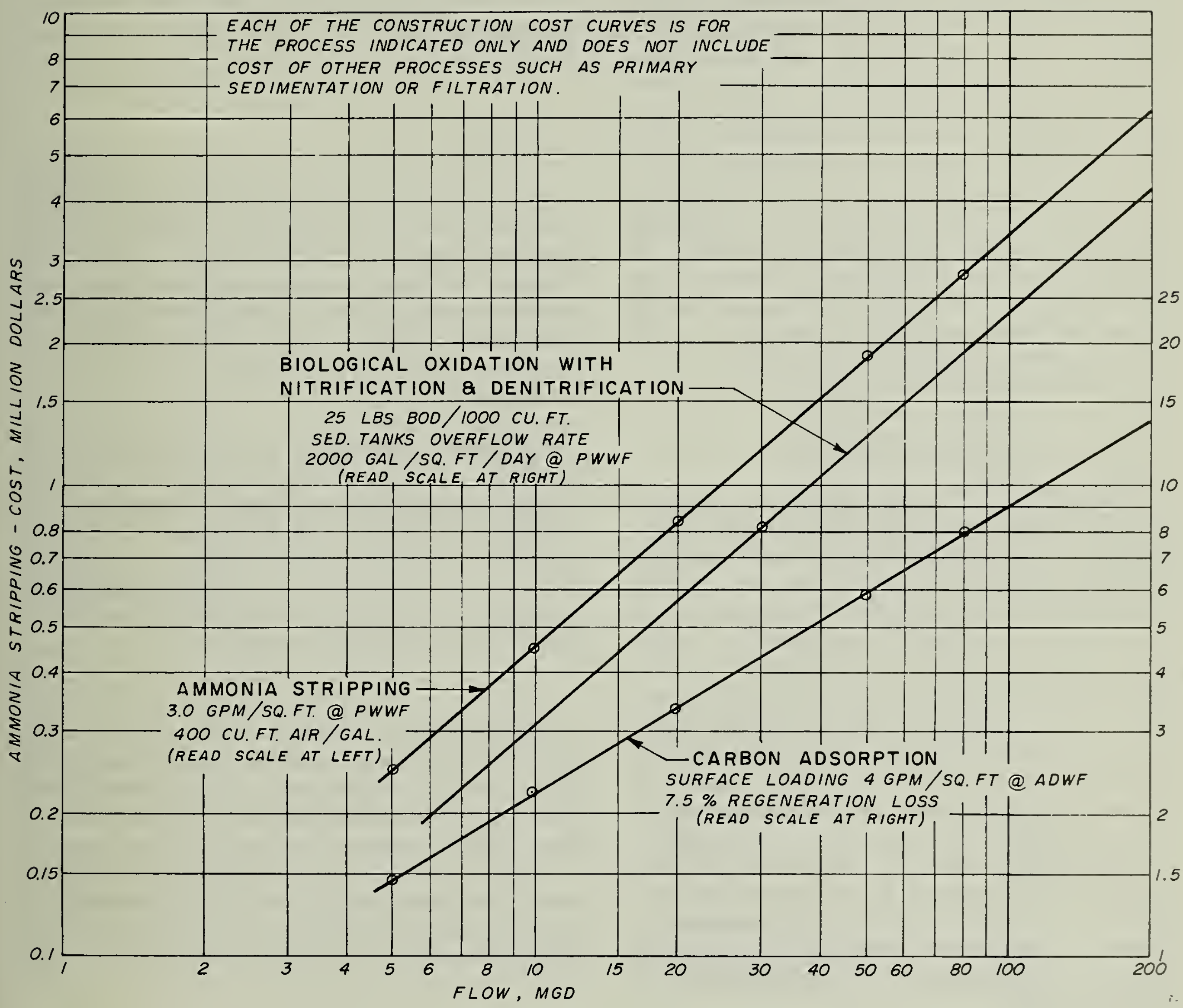

Figure 2-1

Estimated Construction Cost Curves

(Costs are based on an ENR construction cost index of 1700. Curves include the cost of basic structures, channels, major pipelines and contractor's overhead profit but do not include land, special housings, special foundations, or engineering and contingencies.)

from 12 to 20 percent of the contract cost. All work is expected to require large amounts of preliminary investigation to assure that proposed construction is compatible with existing conditions. The lower percentage given above applies to large projects and the higher percentage to small projects. Since the relative size of projects into which the proposed work may be divided cannot be anticipated at this time, engineering costs for the purpose of this report are based on 16 percent of the contract costs. When applied in sequence, construction contingencies and engineering amount to nearly 51 percent of the basic contract cost. An allowance of 50 percent is included in the preliminary cost estimates developed on this report for engineering and contingencies.

OPERATION COSTS

Operation costs are compared on the basis of labor; electric power; other utility costs; chemicals; maintenance, repair and supplies; screening and grit disposal; and other solids disposal for each alternative. Operation costs have been taken from the 1969-70 actual expenditure figures for each plant adjusted to 1971 costs. Adjustments have been made, where warranted by the nature of the improvements, to each operation cost item for each alternative. In some cases 1969-70 quantities are used with the actual expenditures to determine basic unit operating costs. The majority of the descriptive and cost information on each operation item is given in Chapter 5, Report 1, Phase II. The only additional information required for this report involves some miscellaneous utility costs and some additional chemical costs.

Other Utilities

Energy costs for carbon regeneration involve utilities other than electric power. Primarily these include auxiliary fuel and water. While water involves no cost to the treatment division, supplemental fuel will add substantially to the costs. It is estimated that these costs for carbon regeneration facilitites will average $2.50 mil/gal.[6]

Chemicals

Chemical cost is a function of several factors including raw material availability and location, cost of manufacture, and cost of transportation. Chemicals not covered in Report 1, Phase II include methanol, alum and activated carbon. Cost for these chemicals were determined from current market prices and present costs to existing plants.

Methanol. Methanol or methyl alcohol is available locally from the Union Carbide Company. Mehtanol is highly flammable and must be handled in conformance with NBFU codes and local fire department regulations. Methanol is available at approximately $0.27/gal in 40,000 pound liquid shipments. Shipments are by 6000 gallon tankers.

Alum. Alum is available locally in both the liquid and hydrated solid states. In the liquid state it can be delivered in either 3000 or 4500 gal tankers. Liquid alum will usually run about 8.25 percent active alumina (Al_2O_3) and is available at approximately $24/ton. Hydrated solid state alum is available in bulk at about 17 percent active alumina (Al_2O_3) at approximately $49.50/ton.

Activated Carbon. Activated carbon is available from several local suppliers in 2 cu ft bags. Each bag weighs about 63 lbs and sells for $12.60. The cost of activated carbon is therefore approximately $0.20/lb or $400/ton.

CHAPTER 3

ALTERNATIVE PLANS FOR SEWAGE TREATMENT AND DISPOSAL

Report 1, Phase II of this study presents treatment alternatives for the three water pollution control plants (six for two of the plants and five for the other plant) which would provide either complete or partial attainment of the Regional Board goals for turbidity, discoloration, floatables, grease and settleable solids. Although some of these treatment alternatives will meet many of the anticipated receiving water nutrient, phenol, pesticide or metal concentration objectives or effluent toxicity objectives, at least one additional alternative is required at each plant to produce an effluent meeting the highest objective goals for toxicity and nutrient content.

The performance projections for these treatment alternatives, which are given in Appendix A, are based on existing plant performance, information obtained from operating facilities, pilot plant studies in other locales, and the pilot plant studies at North Point. It should be understood, however, that there is very little actual plant scale operating experience for most of the processes suggested. Before actual design is attempted on these alternatives, it is our recommendation that each process is thoroughly investigated with pilot and plant-scale studies.

NORTH POINT WATER POLLUTION CONTROL PLANT

As with the previous development of North Point alternatives, minimum space for expansion limits the selection of feasible treatment processes for attaining the highest goals for effluent toxicity and nutrient content. The following seven alternatives including the six previously reviewed for Report 1, Phase II, were selected for economic analysis:

Alternative	Description
N1 - N4B	Same alternatives as described in Chapter 6 of Report 1, Phase II.
N5	Existing plant and outfall improvements including North Point's share of solids handling improvements and installation of additional thickeners and heat conditioning at the Southeast plant, plus chemical treatment with high dose slaked lime (300-350 mg/l) added ahead of primary sedimentation, recarbonation, filtration, superchlorination, carbon adsorption and effluent pumping.

All alternatives were analyzed on the basis of the following influent loadings:

ADWF	71 mgd
PWWF	200 mgd
BOD	195 mg/l
COD	480 mg/l
TSS	194 mg/l
Ammonia as N	15 mg/l
Total nitrogen as N	34 mg/l
Phosphorous as P	13 mg/l

Alternative N1

Alternative N1 involves modifications to the North Point sewage treatment facilities, including the construction of a deep water outfall, and to the Southeast solids treatment facilities required to improve existing treatment efficiency and reliability.

Reductions Expected. Upon completion of all the proposed existing plant and outfall improvements, it is expected that the following objectives can be attained at the North Point plant:

Alternative N1

Parameter	Objectives
Toxicity	Approximately 2 percent of the 96-hour TL_m concentration of the waste as discharged within one foot of the surface of the receiving water. Compliance with all objectives. Approximately 20 percent survival in effluent for 90 percent of the determinations.
Nutrients	Less than 20 mg/l chlorophyll in receiving water. Compliance with all objectives. Approximately 10 percent removal of total nitrogen (N) entering plant. Approximately 10 percent removal of total phosphorus (P) entering plant.
Phenols	Less than 0.03 mg/l in the receiving water. Compliance with all objectives.
Sulfides	Less than 0.05 mg/l in the receiving water. Compliance with all objectives. Less than 0.10 mg/l in the effluent. Compliance with all objectives.
Pesticides	Less than 0.002 μg/l Lindane, 0.002 μg/l Heptachlor-Epoxide, 0.006 μg/l D.D.T. (including D.D.E. and D.D.D.) and 0.003 μg/l Dieldrin in the receiving water. Compliance with all objectives.
Metals	Less than 0.5 mg/l Hexavalent chromium, 1.0 mg/l total chromium. 0.05 mg/l lead, 0.05 mg/l copper and 0.1 mg/l zinc in the receiving water. Compliance with all objectives. Less than 0.01 cadmium, 1.0 mg/l aluminum, 1.0 mg/l total chromium, 1.0 mg/l zinc, 5.0 mg/l nickel, and 3.0 mg/l arsenic in the effluent. Compliance with all objectives. Approximately 1.5 mg/l iron in the effluent. Approximately 0.20 mg/l copper in the effluent. Approximately 0.10 mg/l lead in the effluent. Approximately 0.015 mg/l mercury in the effluent.

It is also anticipated that alternative N1 will result in a 35 percent reduction in BOD and COD, a 65 percent reduction in suspended solids and no significant reduction in ammonia as N. After disinfection the effluent is expected to have a coliform level of about 1000/100 ml with relatively little virus removal.

Description of Construction. Existing plan improvements include 16 items of construction at the North Point plant and 5 items of construction at the Southeast plant described in Chapter 6 of Report 1, PhaseII.

Description of Operation. See Chapter 6 of Report 1, Phase II.

Estimated Construction Costs. Detailed breakdown of the estimated construction costs by items is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative N1 is $19,136,000.

Estimated Operation Costs. Detailed breakdown of the estimated annual operating costs for alternative N1 is given in Chapter 6 of Report 1, Phase II. Total estimated annual operating cost is $1,541,000.

Alternative N2

Alternative N2 involves existing plant and outfall improvements of alternative N1 combined with a low dose ferric chloride chemical treatment of 15-45 mg/l $FeCl_3$, 1200-1500 mg/l NaCl and 0.25 mg/l polymer. The polymer is added only during the 12 hour peak flow period each day and chemical additions are not required during periods of PWWF.

Reductions Expected. Upon completion of all existing plant and outfall improvements and the installation of the low dose ferric chloride chemical treatment improvements, it is expected that the following objectives can be attained at the North Point plant:

Alternative N2

Parameter	Objectives
Toxicity	Compliance with all receiving water objectives. Approximately 25 percent survival in effluent for 90 percent of the determinations.
Nutrients	Compliance with all receiving water objectives. Approximately 15 percent removal of total nitrogen (N) entering plant. Approximately 50 percent removal of total phosphorus (P) entering plant.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives. Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives.
Metals	Compliance with all receiving water objectives. Compliance with effluent objectives for cadmium, aluminum, total chromium, zinc, nickel and arsenic. Less than 1.0 mg/l iron in the effluent. Compliance with objectives. Approximately 0.10 mg/l copper in the effluent. Approximately 0.08 mg/l lead in the effluent. Approximately 0.010 mg/l mercury in the effluent.

It is also anticipated that alternative N2 will result in a 40 percent reduction in BOD and COD, a 75 percent reduction in suspended solids and no significant reduction in ammonia as N. After disinfection the effluent is expected to have a coliform level of 1000/100 ml with relatively little virus removal.

Description of Construction. Low dose ferric chloride chemical treatment and existing plant improvements include 19 items of construction at the North Point plant and 5 items of construction at the Southeast plant described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, Phase II.

Estimated Construction Costs. Detailed breakdown of the estimated construction costs by items is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative N2 is $23,330,000.

Estimated Operation Costs. Detailed breakdown of the estimated annual operating costs for alternative N2 is given in Chapter 6 of Report 1, Phase II. Total estimated annual operating cost is $1,807,000.

Alternative N3

Alternative N3 involves the existing plant improvements of alternative N1 combined with a low dose slaked lime chemical treatment of 150-175 mg/l $Ca(OH)_2$ with recycling of up to 25 percent of ADWF. Solids produced by this alternative will be much greater than alternatives N1 or N2. Consequently, two alternatives, N3A and N3B, were investigated for solids treatment.

Reductions Expected. Upon completion of all existing plant improvements and the installation of the low dose slaked lime chemical treatment improvements, it is expected that the following objectives can be attained at the North Point plant:

Alternative N3

Parameter	Objective
Toxicity	Compliance with all receiving water objectives. Approximately 30 percent survival in effluent for 90 percent of the determinations.

Nutrients	Compliance with all receiving water objectives. Approximately 15 percent removal of total nitrogen (N) entering plant. Approximately 50 percent removal of total phosphorus (P) entering plant.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives. Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives.
Metals	Compliance with all receiving water objectives. Compliance with all effluent objectives for cadmium, aluminum, total chromium, zinc, iron, nickel and arsenic. Less than 0.005 mg/l copper and lead and 0.005 mg/l mercury in the effluent. Compliance with objectives.

It is anticipated that alternative N3 will result in a 45 percent reduction in BOD and COD, an 80 percent reduction in suspended solids and no significant reduction in ammonia as N. After disinfection the effluent is expected to have a coliform level of 1000/100 ml with relatively little virus removal.

Description of Construction. Low dose slaked lime chemical treatment and existing plant improvements include 19 items of construction at the North Point plant and 4 items of construction at the Southeast plant for alternative N3A and 5 items of construction at the Southeast plant for alternative N3B described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, Phase II.

Estimated Construction Costs. Detail breakdown of estimated construction costs by items is given in Chapter 6 of Report 1, PhaseII. Total estimated construction cost for alternative N3A is $25,390,000 and for alternative N3B is $29,653,000.

Estimated Operation Costs. Detail breakdown of estimated annual operating costs for alternatives N3A and N3B are given in Chapter 6 of Report 1, Phase II. Total estimated annual operating costs are $2,392,000 and $1,901,000, respectively.

Alternative N4A

Alternative N4A involves the existing plant improvements of alternative N1 combined with a high dose slaked lime chemical treatment of 300-350 mg/l $Ca(OH)_2$ with recycling of up to 25 percent of ADWF. The large quantities of solids produced by this alternative will be incinerated at the Southeast plant.

Reductions Expected. Upon completion of all existing plant and outfall improvements and the installation of the high dose slaked lime chemical treatment improvements, it is expected that the following objectives can be attained at the North Point plant.

Alternative N4A

Parameter	Objective
Toxicity	Compliance with all receiving water objectives. Approximately 40 percent survival in effluent for 90 percent of the determinations.
Nutrients	Compliance with all receiving water objectives. Approximately 20 percent removal of total nitrogen (N) entering plant. Approximately 85 percent removal of total phosphorus (P) entering plant.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives. Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives.
Metals	Compliance with all receiving water objectives. Compliance with all effluent objectives.

It is also anticipated that alternative N4A will result in a 70 percent reduction in BOD, a 60 percent reduction in COD, an 87.5 percent reduction in suspended solids and no significant reduction in ammonia as N. After disinfection the effluent is expected to have a coliform level of 240/100 ml with a moderate degree of virus removal.

Description of Construction. High dose slaked lime chemical treatment and existing plant improvements include 19 items of construction at the North Point plant and 5 items of construction at the Southeast plant described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, Phase II.

Estimated Construction Costs. Detailed breakdown of estimated construction costs by items is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative N4A is $33,715,000.

Estimated Operation Costs. Detailed breakdown of estimated annual operating costs for alternative N4A is given in Chapter 6 of Report 1, Phase II. Total estimated annual operating costs are $2,962,000.

Alternative N4B

Alternative N4B involves the existing plant improvements of alternative N1 combined with a high dose ferric chloride chemical treatment of 100-150 mg/l $FeCl_3$, 1200-1500 mg/l NaCl and 0.50 mg/l polymer, filtration and effluent pumping. Flotation thickeners and digesters at the Southeast plant will be used to handle the large quantities of solids produced by this alternative.

Reductions Expected. Upon completiong of all existing plant improvements and the installation of high dose ferric chloride chemical treatment with filtration and effluent pumping, it is expected that the following objectives can be attained at the North Point plant:

Alternative N4B

Parameter	Objective
Toxicity	Compliance with all receiving water objectives. Approximately 30 percent survival in effluent for 90 percent of the determinations.
Nutrients	Compliance with all receiving water objectives. Approximately 20 percent removal of total nitrogen (N) entering plant. Approximately 85 percent removal of total phosphorus (P) entering plant.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives. Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives.
Metals	Compliance with all receiving water objectives. Compliance with all effluent objectives.

It is also anticipated that alternative N4B will result in a 65 percent reduction in BOD, a 60 percent reduction in COD, an 87.5 percent reduction in suspended solids and no significant reduction in ammonia as N. After disinfection the effluent is expected to have a coliform level of 240/100 ml with a moderate degree of virus removal.

Description of Construction. High dose ferric chloride chemical treatment, with filtration and effluent pumping, and existing plant improvements include 21 items of construction at the North Point plant and 5 items of construction at the Southeast plant described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, Phase II.

Estimated Construction Costs. Detail breakdown of estimated construction costs by item is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative N4B is $40,900,000.

Estimated Operation Costs. Detail breakdown of estimated annual operating costs for alternative N4B is given in Chapter 6 of Report 1, Phase II. Total estimated annual operating costs are $2,869,000.

Alternative N5

To improve the effluent with respect to toxicity and nutrient levels, it is necessary to reduce the ammonia and nonbiodegradable organic concentrations. These constituents are relatively untouched by the physical and chemical treatment processes considered in alternatives N1 through N4B. High dose slaked lime treatment with 25 percent recycle at ADWF and solids incineration seems to be the most efficient physical and chemical treatment system and has therefore been selected as the basic process for the high degree treatment alternative.

Ammonia nitrogen removal can be accomplished to the degree required by three different types of treatment processes. These include biological oxidation with nitrification and denitrification, ammonia stripping, and superchlorination. Both of the first two processes require large land areas and are, therefore, not considered economically feasible for the North Point plant. Superchlorination, as operated for about one year at the Blue Plains demonstration plant of the Environmental Protection Agency, consists of dosing effluent from the physical-chemical treatment system with chlorine in amounts equal to ten times the weight of ammonia expressed as equivalent nitrogen. After approximately 6-1/2 minutes of chlorine contact time, the sewage passes through carbon adsorption tanks having about 7 minutes of empty tank detention time.

Blue Plains has found that the final effluent nitrogen level after this treatment is in the magnitude of about 2.5-3.0 mg/l. Because of the high influent nitrate concentrations (2.2 mg/l) at North Point, it is anticipated that the lowest effluent nitrogen concentration that can be achieved will be approximately 5 mg/l. To achieve even this concentration will require increasing the carbon adsorption detention time to 40 minutes to assure maximum removal of organic nitrogen.

Nitrogen reduction will be about 85 percent and is considered the best obtainable within economic limitations. Reductions of more than 90 percent could be achieved if the nitrate level in the plant influent could be reduced to the level found at the other two plants. Although the amount of chlorine used is great, the superchlorination process is extremely reliable and is not upset by temperature changes.

Carbon adsorption after chlorination provides for dechlorination and removal of chloramines and assures the removal of any nonbiodegradable organics which remain unaltered by the other processes. Pumping required for carbon adsorption will provide sufficient head for effluent disposal. Both filtration and carbon tank backwash will be discharged to a holding tank which will be designed to return this flow to the plant influent with minimum upset. Primary solids production, not including chemicals, is expected to be about 10 percent greater than alternative N4A (high dose slaked lime chemical treatment). To compensate for the treatment of these solids, a 3 percent increase in the cost of solids removal, handling and disposal facilities of alternative N4A will be required. Previously built-in design tolerances limit the application of this cost increase to items 6, 7, 9 and 10 of alternative N4A.

Reductions Expected. With the completion of all the proposed existing plant and outfall improvements and the installation of high dose slaked lime chemical treatment with recarbonation, filtration, superchlorination and carbon adsorption, it is expected that the following objectives can be attained at the North Point plant:

Alternative N5

Parameter	Objective
Toxicity	Compliance with all receiving water objectives. Approximately 90 percent survival in effluent for 90 percent of the determinations. Compliance with effluent objectives.
Nutrients	Compliance with all receiving water objectives. Approximately 85 percent removal of total nitrogen (N) entering plant. Approximately 93 percent removal of total phosphorus (P) entering plant. Compliance with effluent objectives.

Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives.
	Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives.
Metals	Compliance with all receiving water objectives.
	Compliance with all effluent objectives.

It is also anticipated that alternative N5 will result in a 94 percent reduction in BOD, a 94 percent reduction in COD, a 98 percent reduction in suspended solids and a 100 percent reduction in ammonia as (N). After treatment, the effluent is expected to have a coliform level of 2.2/100 ml with a consistently high degree of virus removal.

Description of Construction. Alternative N5, which involves high dose slaked lime chemical treatment, recarbonation, filtration, superchlorination, carbon adsorption and effluent pumping plus existing plant improvements, includes the following sewage treatment construction:

1. Construction of improvements to the existing North Point plant as listed in items 1-6, 8 and 11-16, alternative N1, Report 1, Phase II.
2. Installation of chemical storage and feeding facilities as recommended in item 2, alternative N4A, Report 1, Phase II.
3. Installation of new preaeration flocculation tanks as recommended in item 3, alternative N3, Report 1, Phase II.
4. Installation of preaeration flocculator recycling facilities as recommended in item 4, alternative N3, Report 1, Phase II.
5. Installation of a sedimentation tank effluent control system designed to maintain the water level in the tanks to plus or minus one-half inch. Control system will consist of control valves of the butterfly type used to throttle the flow between the sedimentation and recarbonation tanks. Butterfly valves will be provided with individual package hydraulic power positioners similar to the influent gate power units of item 1, alternative N1, Report 1, Phase II. Sedimentation tank level and valve position instrumentation and controls will be connected to the centralized control system.
6. Installation of recarbonation facilities including fiberglass carbon dioxide storage tanks and equipment and apparatus required to introduce the gaseous CO_2 to the flow downstream from the sedimentation tank effluent control valves and upstream from the dual-media filters. The recarbonation system will be as recommended in item 5, alternative N4A, Report 1, Phase II, except that it will be provided with a total of 8-1/2 minutes of detention time.
7. Installation of nine bifurcated dual-media filters as recommended in item 6, alternative N4B, Report 1, Phase II.
8. Modification of chlorination facilities including additional chlorination capacity for superchlorination, new chlorine handling pipelines, revisions to prechlorination diffusers, new superchlorination diffusers and control instrumentation. Chlorination capacity additions will be based on prechlorination at existing levels for all flows and superchlorinating with 150 mg/l Cl_2 for flows up to approximately 125 mgd and will consist of two additional 50 ton liquid storage tanks, new vandal-proof storage housing facilities and twenty additional 8000 lb/day evaporator-chlorinator combinations. Superchlorination chlorine vacuum piping will be designed to allow three units to standby for any of the other eighteen units. Two prechlorination evaporator-chlorinator combinations will be piped to standby for each other.

Chlorine handling pipelines will be changed to handle chlorine gas under vacuum with the prechlorination injector and eighteen superchlorination injectors located in the field at the point of application. Prechlorination diffusers will be relocated and redesigned to maintain efficient application and mixing with a minimum of gaseous release. Prechlorination will take place immediately upstream from the influent throttling sluice gate. Superchlorination diffusers will be located immediately downstream from the dual-media filter head loss control valves. Each superchlorination diffuser will consist of a short pipe applicator followed immediately by an in-line, propeller type mixer. Each diffuser will be capable of handling the complete output of an evaporator-chlorinator combination. Eighteen injector water pumps will provide up to 350 gpm for each superchlorination injector. Instrumentation signals and controls will be tied into the centralized control system.

9. Installation of a superchlorination contact chamber designed to provide six and one half minutes of detention time at PWWF. Chamber will be designed in several compartments so that each may be taken out of service periodically for cleaning. Chamber design will minimize short circuiting, provide a positive head for the superchlorination mixers, and a positive suction head for the carbon adsorption system influent pumps and the superchlorination injector water pumps.

10. Installation of a carbon adsorption system complete with eleven 40 ft diameter, 50 feet high carbon towers designed to provide 40 minutes of empty bed detention time at a downward application rate of 4 gpm/sq ft at ADWF with one standby tower and sufficient hydraulic capacity to handle PWWF; influent pumps; effluent collection and discharge chamber and complete carbon regeneration facilities. Each tank will be provided with 740 tons of 16 x 40 mesh granular activated carbon, effluent and air backwash facilities, adequate space for bed expansion during backwash and facilities for draining and recharging the carbon bed. Towers will be designed for a 50 psi working pressure.

Carbon adsorption influent pumps will be located in the superchlorination gallery. Pumps will have capacity to pump the PWWF through the adsorption towers and the submarine outfall to San Francisco Bay against the highest high tide. Thirteen pumps will be provided with any eleven capable of handling the peak flow. All pumps will have variable speed electric drives and completely automatic controls.

A common effluent collection chamber will provide a suction supply for two 12.5 mgd backwash water pumps. It is anticipated that backwashing will require from 3 to 4 percent of the sorption effluent. Backwashing will be controlled by flow control valves designed to maintain a positive suction on the backwash water pumps, regardless of flow or receiving water elevation. Control valve controls will be similar to those described for the sedimentation tank effluent control system in item 5.

Carbon regeneration facilities will consist of transportation equipment, multiple hearth furnace regenerator, quench tank and carbon make-up storage and feeding equipment. Carbon will be regenerated at 1650° to 1700°F. Carbon regeneration will be controlled by COD removal efficiency. Carbon exhaustion is assumed to be 100 lbs carbon per 50 lbs COD removed with 7-1/2 percent makeup.

The complete carbon adsorption facilities will be housed in an enclosed structure with suitable ventilation and equipment access facilities and adequate noise and odor control. All flow and backwash controls will be automatic. Instrumentation signals and controls will be connected to the centralized control system.

11. Revision of existing outfall system as recommended under item 10, alternative N1, Report 1, Phase II except for the operation of the effluent control valves. These valves are included under item 10.

In addition to the North Point plant improvements, the following revisions and modifications must be made to solids handling and disposal facilities at the Southeast plant.

12. Renovation of existing solids gravity thickening facilities and installation of new additional units as listed under item 6, alternative N4A, Report 1, Phase II plus a 3 percent allowance for increased solids.

13. Renovation and enlargement of the existing sludge filtering system as listed under item 7, alternative N4A, Report 1, Phase II plus a 3 percent allowance for increased solids.

14. Cleaning and renovation of digesters 1 and 2 for raw sludge holding tanks as recommended for item 12, alternative N3B, Report 1, Phase II.

15. Installation of three 98 dry tons/day, 22.25 ft diameter, 9 hearth incinerators, all similar but 3 percent larger than the facilities recommended for item 9, alternative N4A, Report 1, Phase II.

16. Installation of vacuum filter filtrate electrolytic treatment facilities as recommended for item 10, alternative N4A, Report 1, Phase II plus a 3 percent allowance for increased solids.

Description of Operation. The high dose slaked lime chemical treatment process plus recarbonation, filtration, superchlorination, carbon adsorption with effluent pumping and existing plant and outfall improvements proposed under alternative N5 will require more manpower than any other North Point plant alternative. It is anticipated the calcium oxide handling and mixing equipment, recarbonation equipment, filtration and superchlorination

equipment and carbon adsorption equipment will require the equivalent of five full-time maintenance operators in addition to the other personnel required for alternative N1, Report 1, Phase II. With continuous duty, these maintenance operator positions alone will entail the addition of at least 25 new personnel. In addition, it is expected that the increased sludge handling and disposal facilities at the Southeast plant will also require at least ten new personnel.

Alternative N5 will require large amounts of power. Power use greater than that of alternative N1, Report 1, Phase II will result from the chemical handling facilities, underflow recycling, carbon dioxide diffusion, filter backwash, chlorine evaporation, chlorine diffusion, carbon adsorption pumping, adsorption tower backwash and regenerated carbon handling at the North Point plant, and from solids thickening, filtering and incineration facilities at the Southeast plant. If the underflow recycling averages 10 percent of the plant flow, filter backwash 8-1/2 percent of the plant flow and carbon adsorption backwash 3-1/2 percent of the plant flow, it is estimated that the extra power over 1969-70 use will involve the continuous running of approximately 5,340 horsepower. Except for carbon regeneration and solids incineration fuel costs, other utility costs are expected to remain about the same as for alternative N1, Report 1. Phase II. Carbon regeneration utility costs exclusive of power are expected to average about $177 per day. Incinerators are expected to use about 3,600 therms/day of natural gas.

Influent chlorine use under alternative N5 will remain the same as alternative N1, Report 1, Phase II at 3 mg/l or 1,760 lbs/day. As with alternative N4A, Report 1, Phase II, no chlorine will be used for raw sludge. Superchlorination chlorine requirements are expected to average about 150 mg/l or 90,000 lbs/day. Salt requirements for odor control will remain at about 6,000 lbs/day and it is estimated that approximately 79.5 tons/day of calcium oxide will be required to provide the necessary chemical treatment. Carbon dioxide use is expected to average 16.9 tons/day and activated carbon make-up about 8.0 tons/day. No chemicals will be required for filter cake production.

Changes in maintenance and repair costs between alternatives N1, Report 1, Phase II and alternative N5 are expected to parallel the increased investment in equipment and facilities.

Screening and grit disposal costs are expected to be the same as alternative N4A, Report 1, Phase II. Incineration system is expected to produce an average of approximately 180 tons/day of damp ash (20 percent moisture) to be hauled to land-fill disposal.

Estimated Construction Cost. Estimated construction costs, including engineering and contingencies, for alternative N5 which provides for existing plant improvements plus high dose slaked lime chemical treatment, filtration, superchlorination, carbon adsorption and effluent pumping are presented below. Costs are given for each item discussed in the preceding section and are based on 1971 prices.

Alternative N5

Sewage Treatment		Solids Treatment	
1.	$ 8,651,000	12.	$ 1,761,000
2.	681,000	13.	1,736,000
3.	2,100,000	14.	750,000
4.	75,000	15.	9,007,000
5.	60,000	16.	1,097,000
6.	3,065,000	Subtotal	$14,351,000
7.	13,420,000	TOTAL	$77,573,000
8.	3,825,000		
9.	2,130,000		
10.	22,275,000		
11.	6,940,000		
Subtotal	$63,222,000		

If all work must be completed by 1975, these costs should be increased by approximately 25 percent or $19,400,000.

Estimated Operation Costs. Estimated annual operating costs for existing plant improvements plus high dose lime chemical treatment with filtration, superchlorination, carbon adsorption and effluent pumping are based on 1971 prices and are as follows:

	Alternative N5
Labor	$ 1,425,000
Electric power	424,000
Other utilities	171,000
Chemicals	2,520,000
Maintenance, repair and supplies	223,000
Screening and grit disposal	5,000
Other solids disposal	297,000
Total	$ 5,065,000

Summary

Table 3-1 presents the predicted plant performance for each of the alternatives proposed for the North Point plant. Table 3-2 summarizes estimated construction and operating costs of the alternatives.

Table 3 - 1

Predicted Performance of Alternative Treatment Processes
North Point Water Pollution Control Plant

Alternative	Toxicity		Nutrients			Phenols	Sulfides	
	Percent 96-hr TLm conc wastes in rec water	Percent survival in effluent 90 percent of time	Rec water chlorophyll level mg/l	Percent removal total N in influent	Percent removal total P in influent	Rec water conc mg/l	Rec water conc mg/l	Effluent conc mg/l
N1	< 5[b]	20[a]	<20[b]	10[a]	10[a]	< 0.03[b]	< 0.05[b]	< 0.10[b]
N2	< 5[b]	25[a]	< 20[b]	15[a]	50[a]	< 0.03[b]	< 0.05[b]	< 0.10[b]
N3	< 5[b]	30[a]	< 20[b]	15[a]	50[a]	< 0.03[b]	< 0.05[b]	< 0.10[b]
N4A	< 5[b]	40[a]	< 20[b]	20[a]	85[a]	< 0.03[b]	< 0.05[b]	< 0.10[b]
N4B	< 5[b]	30[a]	< 20[b]	20[a]	85[a]	< 0.03[b]	< 0.05[b]	< 0.10[b]
N5	< 5[b]	90[b]	< 20[b]	85[ac]	93[b]	< 0.03[b]	< 0.05[b]	< 0.10[b]

Alternative	Pesticides				Metals				
	Receiving water concentrations				Receiving water concentrations				
	Lindane μg/l	Heptachlor epoxide μg/l	D.D.T. (incl D.D.E. and D.D.D.) μg/l	Dieldrin μg/l	Hexavalent chromium mg/l	Total chromium mg/l	Lead mg/l	Copper mg/l	Zinc mg/l
N1	< 0.002[b]	< 0.002[b]	< 0.006[b]	< 0.003[b]	< 0.5[b]	< 1.0[b]	< 0.05[b]	< 0.05[b]	< 0.1[b]
N2	< 0.002[b]	< 0.002[b]	< 0.006[b]	< 0.003[b]	< 0.5[b]	< 1.0[b]	< 0.05[b]	< 0.05[b]	< 0.1[b]
N3	< 0.002[b]	< 0.002[b]	< 0.006[b]	< 0.003[b]	< 0.5[b]	< 1.0[b]	< 0.05[b]	< 0.05[b]	< 0.1[b]
N4A	< 0.002[b]	< 0.002[b]	< 0.006[b]	< 0.003[b]	< 0.5[b]	< 1.0[b]	< 0.05[b]	< 0.05[b]	< 0.1[b]
N4B	< 0.002[b]	< 0.002[b]	< 0.006[b]	< 0.003[b]	< 0.5[b]	< 1.0[b]	< 0.05[b]	< 0.05[b]	< 0.1[b]
N5	< 0.002[b]	< 0.002[b]	< 0.006[b]	< 0.003[b]	< 0.5[b]	< 1.0[b]	< 0.05[b]	< 0.05[b]	< 0.1[b]

[a] Meets minimum stipulated objective.

[b] Meets maximum stipulated objective.

[c] Further reduction requires elimination of influent nitrates.

equipment and carbon adsorption equipment will require the equivalent of five full-time maintenance operators in addition to the other personnel required for alternative N1, Report 1, Phase II. With continuous duty, these maintenance operator positions alone will entail the addition of at least 25 new personnel. In addition, it is expected that the increased sludge handling and disposal facilities at the Southeast plant will also require at least ten new personnel.

Alternative N5 will require large amounts of power. Power use greater than that of alternative N1, Report 1, Phase II will result from the chemical handling facilities, underflow recycling, carbon dioxide diffusion, filter backwash, chlorine evaporation, chlorine diffusion, carbon adsorption pumping, adsorption tower backwash and regenerated carbon handling at the North Point plant, and from solids thickening, filtering and incineration facilities at the Southeast plant. If the underflow recycling averages 10 percent of the plant flow, filter backwash 8-1/2 percent of the plant flow and carbon adsorption backwash 3-1/2 percent of the plant flow, it is estimated that the extra power over 1969-70 use will involve the continuous running of approximately 5,340 horsepower. Except for carbon regeneration and solids incineration fuel costs, other utility costs are expected to remain about the same as for alternative N1, Report 1. Phase II. Carbon regeneration utility costs exclusive of power are expected to average about $177 per day. Incinerators are expected to use about 3,600 therms/day of natural gas.

Influent chlorine use under alternative N5 will remain the same as alternative N1, Report 1, Phase II at 3 mg/l or 1,760 lbs/day. As with alternative N4A, Report 1, Phase II, no chlorine will be used for raw sludge. Superchlorination chlorine requirements are expected to average about 150 mg/l or 90,000 lbs/day. Salt requirements for odor control will remain at about 6,000 lbs/day and it is estimated that approximately 79.5 tons/day of calcium oxide will be required to provide the necessary chemical treatment. Carbon dioxide use is expected to average 16.9 tons/day and activated carbon make-up about 8.0 tons/day. No chemicals will be required for filter cake production.

Changes in maintenance and repair costs between alternatives N1, Report 1, Phase II and alternative N5 are expected to parallel the increased investment in equipment and facilities.

Screening and grit disposal costs are expected to be the same as alternative N4A, Report 1, Phase II. Incineration system is expected to produce an average of approximately 180 tons/day of damp ash (20 percent moisture) to be hauled to land-fill disposal.

Estimated Construction Cost. Estimated construction costs, including engineering and contingencies, for alternative N5 which provides for existing plant improvements plus high dose slaked lime chemical treatment, filtration, superchlorination, carbon adsorption and effluent pumping are presented below. Costs are given for each item discussed in the preceding section and are based on 1971 prices.

Alternative N5

Sewage Treatment		Solids Treatment	
1.	$ 8,651,000	12.	$ 1,761,000
2.	681,000	13.	1,736,000
3.	2,100,000	14.	750,000
4.	75,000	15.	9,007,000
5.	60,000	16.	1,097,000
6.	3,065,000	Subtotal	$14,351,000
7.	13,420,000	TOTAL	$77,573,000
8.	3,825,000		
9.	2,130,000		
10.	22,275,000		
11.	6,940,000		
Subtotal	$63,222,000		

If all work must be completed by 1975, these costs should be increased by approximately 25 percent or $19,400,000.

Estimated Operation Costs. Estimated annual operating costs for existing plant improvements plus high dose lime chemical treatment with filtration, superchlorination, carbon adsorption and effluent pumping are based on 1971 prices and are as follows:

	Alternative N5
Labor	$ 1,425,000
Electric power	424,000
Other utilities	171,000
Chemicals	2,520,000
Maintenance, repair and supplies	223,000
Screening and grit disposal	5,000
Other solids disposal	297,000
Total	$ 5,065,000

Summary

Table 3-1 presents the predicted plant performance for each of the alternatives proposed for the North Point plant. Table 3-2 summarizes estimated construction and operating costs of the alternatives.

Table 3 - 1

Predicted Performance of Alternative Treatment Processes North Point Water Pollution Control Plant

Alternative	Toxicity		Nutrients			Phenols	Sulfides	
	Percent 96-hr TLm conc wastes in rec water	Percent survival in effluent 90 percent of time	Rec water chlorophyll level mg/l	Percent removal total N in influent	Percent removal total P in influent	Rec water conc mg/l	Rec water conc mg/l	Effluent conc mg/l
N1	< 5[b]	20[a]	<20[b]	10[a]	10[a]	< 0.03[b]	<0.05[b]	< 0.10[b]
N2	< 5[b]	25[a]	< 20[b]	15[a]	50[a]	<0.03[b]	<0.05[b]	<0.10[b]
N3	< 5[b]	30[a]	<20[b]	15[a]	50[a]	<0.03[b]	<0.05[b]	<0.10[b]
N4A	< 5[b]	40[a]	<20[b]	20[a]	85[a]	<0.03[b]	<0.05[b]	<0.10[b]
N4B	< 5[b]	30[a]	< 20[b]	20[a]	85[a]	<0.03[b]	<0.05[b]	<0.10[b]
N5	< 5[b]	90[b]	< 20[b]	85[ac]	93[b]	< 0.03[b]	<0.05[b]	<0.10[b]

Alternative	Pesticides				Metals				
	Receiving water concentrations				Receiving water concentrations				
	Lindane µg/l	Heptachlor epoxide µg/l	D.D.T. (incl D.D.E. and D.D.D.) µg/l	Dieldrin µg/l	Hexavalent chromium mg/l	Total chromium mg/l	Lead mg/l	Copper mg/l	Zinc mg/l
N1	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	< 1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
N2	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	< 1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
N3	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	< 1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
N4A	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	< 1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
N4B	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	< 1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
N5	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	< 1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]

[a]Meets minimum stipulated objective.

[b]Meets maximum stipulated objective.

[c]Further reduction requires elimination of influent nitrates.

Table 3 - 1

Predicted Performance of Alternative Treatment Processes (Continued)
North Point Water Pollution Control Plant

Alternative	Effluent concentrations									
	Cadmium mg/l	Aluminum mg/l	Total chromium mg/l	Copper mg/l	Zinc mg/l	Iron mg/l	Nickel mg/l	Lead mg/l	Mercury mg/l	Aresnic mg/l
N1	< 0.01[b]	< 1.0[b]	< 1.0[b]	0.20[a]	< 1.0[b]	1.5[a]	< 5.0[b]	0.10[a]	0.015	< 3.0[b]
N2	< 0.01[b]	< 1.0[b]	< 1.0[b]	0.10[a]	< 1.0[b]	< 1.0[b]	< 5.0[b]	0.08[a]	0.010	< 3.0[b]
N3	< 0.01[b]	< 1.0[b]	< 1.0[b]	< 0.05[b]	< 1.0[b]	< 1.0[b]	< 5.0[b]	< 0.05[b]	< 0.005[b]	< 3.0[b]
N4A	< 0.01[b]	< 1.0[b]	< 1.0[b]	< 0.05[b]	< 1.0[b]	< 1.0[b]	< 5.0[b]	< 0.05[b]	< 0.005[b]	< 3.0[b]
N4B	< 0.01[b]	< 1.0[b]	< 1.0[b]	< 0.05[b]	< 1.0[b]	< 1.0[b]	< 5.0[b]	< 0.05[b]	< 0.005[b]	< 3.0[b]
N5	< 0.01[b]	< 1.0[b]	< 1.0[b]	< 0.05[b]	< 1.0[b]	< 1.0[b]	< 5.0[b]	< 0.05[b]	< 0.005[b]	< 3.0[b]

[a]Meets minimum stipulated objective.

[b]Meets maximum stipulated objective.

Table 3 - 2

Estimated Construction and Operating Costs of Alternative
Treatment Processes
North Point Water Pollution Control Plant

Alternative	Estimated construction cost, dollars[a]	Estimated annual operating cost, dollars
N1	19,136,000	1,541,000
N2	23,330,000	1,807,000
N3A	25,390,000	2,392,000
N3B	29,653,000	1,901,000
N4A	33,715,000	2,962,000
N4B	40,900,000	2,869,000
N5	77,573,000	5,065,000

[a]No land costs included. See appendix D for addtional land area required for each alternative.

RICHMOND-SUNSET WATER POLLUTION CONTROL PLANT

With the possibility of obtaining reasonable land area within Golden Gate Park, the limits of selection for a feasible treatment process to attain the highest goals for Richmond-Sunset effluent toxicity and nutrient content are greatly expanded. The following eight alternatives, including the five previously reviewed for Report 1, Phase II, were selected for economic analysis:

Alternative	Description
R1 - R4B	Same descriptions as provided in Chapter 6 of Report 1, Phase II.
R5A	Existing plant improvements including the outfall extension plus chemical treatment with high dose slaked lime (240-280 mg/l) added ahead of primary sedimentation, recarbonation, filtration, superchlorination and carbon adsorption.

R5B	Existing plant improvements including the outfall extension plus chemical treatment with high dose slaked lime (240-280 mg/l) added ahead of primary sedimentation, recarbonation, ammonia stripping, biological oxidation, filtration and carbon adsorption.
R5C	Existing plant improvements, including the outfall extension plus biological oxidation with nitrification, denitrification with chemical addition, filtration and carbon adsorption.

All alternatives were analyzed on the basis of the following influent loadings:

ADWF	28 mgd
PWWF	70 mgd
BOD	180 mg/l
COD	490 mg/l
TSS	190 mg/l
Ammonia as N	22 mg/l
Total nitrogen as N	37 mg/l
Phosphorus as P	17 mg/l

In the alternative providing treatment required to meet the most stringent toxicity requirements, carbon adsorption is provided to assure that any refractory organic nonbiodegradable wastes which might be getting into the Richmond-Sunset sewage are removed to meet effluent toxicity goals. It is anticipated wastes containing these constituents might originate at the many hospital complexes tributary to the system. In addition, it is assumed that sufficient excess capacity exists, or is provided, under all alternatives to assimilate the toxic, nutrient and hydraulic loadings resulting from return of liquid fractions from the solids treatment process.

Alternative R1

Alternative R1 involves modifications to the Richmond-Sunset sewage treatment facilities, including the construction of an effluent pumping station and deep water outfall, to improve existing treatment efficiency and reliability.

Reductions Expected. Upon completion of all the proposed existing plant and outfall improvements, it is expected that the following objectives can be attained at the Richmond-Sunset plant:

Alternative R1

Parameter	Objectives
Toxicity	Approximately 6 percent of the 96-hour TLm concentration of the waste as discharged within one foot of the surface of the receiving water. Compliance with all objectives.
	Approximately 10 percent survival in effluent for 90 percent of the determinations.
Nutrients	Less than 10 mg/l chlorophyll in receiving water.
	Compliance with all objectives.
	Approximately 10 percent removal ot total nitrogen (N) entering plant.
	Approximately 10 percent removal of total phosphorus (P) entering plant.
Phenols	Less than 0.03 mg/l in the receiving water. Compliance with all objectives.
Sulfides	Less than 0.05 mg/l in the receiving water. Compliance with all objectives.
	Less than 0.10 mg/l in the effluent. Compliance with all objectives.
Pesticides	Less than 0.002 μg/l lindane, 0.002 μg.)l heptachloropoxide, 0.006 μg/l D. D. T. (including D. D. E. and D. D. D.) and 0.003 μg/l dieldrin in the receiving water.
	Compliance with all objectives.
Metals	Less than 0.5 mg/l hexavalent chromium, 1.0 mg/l total chromium, 0.05 mg/l lead, 0.05 mg/l copper and 0.1 mg/l zinc in the receiving water. Compliance with allall objectives.
	Less than 1.0 mg/l total chromium, 0.05 mg/l lead, 1.0 mg/l zinc, 1.0 mg/l iron, 5.0 mg/l nickel in the effluent and 3.0 mg/l arsenic. Compliance with all objectives.
	Approximately 0.03 mg/l cadmium in the effluent.
	Approximately 1.5 mg/l aluminum in the effluent.
	Approximately 0.05 mg/l copper in the effluent.
	Approximately 0.020 mg/l mercury in the effluent.

It is also anticipated that alternative R1 will result in a 35 percent reduction of BOD and COD, a 65 percent reduction in suspended solids and no significant reduction in ammonia as N. After disinfection, the effluent is expected to have a coliform level of 1000/100 ml with relatively little virus removal.

Description of Construction. Existing plant improvements include the 23 items of construction described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, Phase II.

Estimated Construction Costs. Detailed breakdown of the estimated construction costs by items is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative R1 is $11,831,000.

Estimated Operation Costs. Detailed breakdown of the estimated annual operatin costs for alternative R1 is given in Chapter 6 of Report 1, Phase II. Total estimated annual operating cost is$682,000.

Alternative R2

Alternative R2 involves the existing plant and outfall improvements of alternative R1 combined with dissolved air flotation of the settled sewage. This alternative is the only completely physical treatment process combination which will improve plant effluent quality.

Reductions Expected. Upon completion of all existing plant and outfall improvements and the installation of dissolved air flotation, it is expected that the following objectives can be attained at the Richmond-Sunset plant:

Alternative R2

Parameter	Objectives
Toxicity	Compliance with all receiving water objectives. Approximately 15 percent survival in effluent for 90 percent of the determinations.
Nutrients	Compliance with all receiving water objectives. Approximately 10 percent removal of total nitrogen (N) entering plant. Approximately 20 percent removal of total phosphorus (P) entering plant.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives. Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives.
Metals	Compliance with all receiving water objectives. Compliance with effluent objectives for total chromium, lead, zinc, iron, nickel and arsenic. Approximately 0.03 mg/l cadmium in the effluent. Approximately 1.5 mg/l aluminum in the effluent. Less than 0.05 copper in the effluent. Compliance with all objectives. Approximately 0.015 mg/l mercury in the effluent.

It is also anticipated that alternative R2 will result in a 40 percent reduction of BOD and COD, a 78 percent reduction in suspended solids and no significant reduction in ammonia as N. After disinfection the effluent is expected to have a coliform level of 1000/100 ml with relatively little virus removal.

Description of Construction. Dissolved air flotation and existing plant and outfall improvements include the 25 items of construction described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, Phase II,

Estimated Construction Costs. Detailed breakdown of the estimated construction costs by items is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative R2 is $14,751,000.

Estimated Operation Costs. Detailed breakdown of the estimated annual operating cost for alternative R2 is given in Chapter 6 of Report 1, Phase II. Total estimated annual operating cost is $789,000.

Alternative R3

Alternative R3 involves the existing plant and outfall improvements of alternative R1 combined with a low dose ferric chloride chemical treatment of 15-45 mg/l $FeCl_3$, 1200-1500 mg/l NaCl and 0.25 mg/l polymer. Polymer is added only during the 12 hour peak flow period each day and all chemical addition is eliminated during periods of PWWF.

Reductions Expected. Upon completion of all existing plant and outfall improvements and the installation of the low dose ferric chloride chemical treatment improvements, it is expected that the following objectives can be attained at the Richmond-Sunset plant:

Alternative R3

Parameter	Objectives
Toxicity	Compliance with all receiving water objectives. Approximately 25 percent survival in effluent for 90 percent of the determinations.
Nutrients	Compliance with all receiving water objectives. Approximately 15 percent removal of total nitrogen (N) entering plant. Approximately 50 percent removal of total phosphorus (P) entering plant.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives. Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives.
Metals	Compliance with all receiving water objectives. Compliance with effluent objectives for total chromium, copper, lead, zinc, iron, nickel and arsenic. Approximately 0.01 mg/l cadmium in the effluent. Approximately 0.010 mg/l mercury in the effluent.

It is also anticipated that alternative R3 will result in a 40 percent reduction in BOD and COD, a 75 percent reduction in suspended solids and no significant reduction in ammonia as N. After disinfection the effluent is expected to have a coliform level of 1000/100 ml with relatively little virus removal.

Description of Construction. Low dose ferric chloride chemical treatment and existing plant and outfall improvements include 27 items of construction described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, Phase II.

Estimated Construction Costs. Detailed breakdown of the estimated construction costs by items is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative R3 is $13,657,000.

Estimated Operation Costs. Detailed breakdown of the estimated annual operating costs for alternative R3 is given in Chapter 6 of Report 1, Phase II. Total estimated annual operating cost is $798,000.

Alternative R4A

Alternative R4A involves the existing plant and outfall improvements of alternative R1 combined with biological oxidation (activated sludge) treatment of the settled sewage. Oxidation of only carbonaceous matter will be achieved under the aeration tank loading of 50 lbs applied BOD/1000 cu ft of tank volume used under this alternative.

Reductions Expected. Upon completion of all existing plant and outfall improvements and the installation of activated sludge biological treatment, it is expected that the following objectives can be attained at the Richmond-Sunset plant:

Alternative R4A

Parameter	Objective
Toxicity	Compliance with all receiving water objectives. Approximately 30 percent survival in effluent for 90 percent of the determinations.

Nutrients	Compliance with all receiving water objectives. Approximately 30 percent removal of total nitrogen (N) entering plant. Approximately 35 percent removal of total phosphorus (P) entering plant.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives. Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives.
Metals	Compliance with all receiving water objectives. Compliance with effluent objectives for total chromium, copper, lead, zinc, iron, nickel and arsenic. Approximately 0.02 mg/l cadmium in the effluent. Approximately 1.0 mg/l aluminum in the effluent. Approximately 0.035 mg/l mercury in the effluent.

It is also anticipated that alternative R4A will result in a 90 percent reduction in BOD, an 80 percent reduction in COD, and 87.5 percent reduction in suspended solids and about a 10 percent reduction in ammonia as N. After disinfection the effluent is expected to have a coliform level of 240/100 ml with relatively little virus removal.

Description of Construction. Activated sludge biological treatment and existing plant and outfall improvements include the 21 items of construction described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, Phase II.

Estimated Construction Costs. Detailed breakdown of the estimated construction costs by items is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative R4A is $20,211,000.

Estimated Operation Costs. Detailed breakdown of the estimated annual operating costs for alternative R4A is given in Chapter 6 of Report 1, Phase II. Total estimated annual operating cost is $893,000.

Alternative R4B

Alternative R4B involves the existing plant and outfall improvements of alternative R1 combined with a high dose slaked lime chemical treatment of 240 to 280 mg/l $Ca(OH)_2$ with recycling of up to 25 percent of ADWF. Solids produced will be incinerated, with recalcined lime utilized to reduce new chamical requirements.

Reductions Expected. Upon completion of all existing plant and outfall improvements and the installation of the high dose slaked lime chemical treatment, it is expected that the following objectives can be attained at the Richmond-Sunset plant:

Alternative R4B

Parameter	Objective
Toxicity	Compliance with all receiving water objectives. Approximately 40 percent survival in efluent for 90 percent of the determinations.
Nutrients	Compliance with all receiving water objectives. Approximately 20 percent removal of total nitrogen (N) entering plant. Approximately 85 percent removal of total phosphorus (P) entering plant.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives. Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives.
Metals	Compliance with all receiving water objectives. Compliance with all effluent objectives for total chromium, copper, lead, zinc, iron, nickel and arsenic. Less than 0.01 mg/l cadmium. 1.0 mg/l aluminum, 0.005 mg/l mercury in the effluent. Compliance with all effluent objectives.

It is also anticipated that alternative R4B will result in a 70 percent reduction in BOD, a 60 percent reduction in COD, an 87.5 percent reduction in suspended solids and no significant reduction in ammonia as N. After disinfection the effluent is expected to have a coliform level of 240/100 ml with a moderate degree of virus removal.

Description of Construction. High dose slaked lime chemical treatment and existing plant and outfall improvements include the 28 items of construction described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, Phase II.

Estimated Construction Costs. Detailed breakdown of the estimated construction costs by items is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative R4B is $17,561,000.

Estimated Operation Costs. Detailed breakdown of the estimated annual operating costs for alternative R4B is given in Chapter 6 of Report 1, Phase II. Total estimated annual operating cost is $1,078,000,

Alternative R5A

To improve effluent quality with regard to toxicity and nutrient concentration it is necessary to remove the ammonia and nonbiodegradable organics which are relatively untouched by the physical, biological and chemical treatment processes considered in alternatives R1 through R4B. One alternative which will achieve the necessary nutrient improvements involves the combination of alternative R4B with filtration and superchlorination. When these alternatives are further combined with carbon adsorption, increased removals of nonbiodegradable organics will assure the necessary improvements in effluent toxicity. Alternative R5A, therefore, will include the physical-chemical treatment process described under alternative R4B followed by filtration, superchlorination and carbon adsorption.

It is anticipated that the suspended solids removal, exclusive of chemicals, under alternative R5A will be about 10 percent greater than R4B. To compensate for the treatment of these solids, a 3 percent increase in the costs of solids removal, handling and disposal facilities of alternative R4B will be required. Previously built-in design tolerances limit the application of this cost increase to items 10, 11 and 12 of alternative R4B.

Reductions Expected. With the completion of all the proposed existing plant and outfall improvements and the installation of high dose slaked lime chemical treatment with recarbonation, filtration, superchlorination and carbon adsorption, it is expected that the following objectives can be attained at the Richmond-Sunset plant:

Alternative R5A

Parameter	Objectives
Toxicity	Compliance with all receiving water objectives.
	Approximately 90 percent survival in effluent for 90 percent of the determinations. Compliance with effluent objectives.
Nutrients	Compliance with all receiving water objectives.
	Approximately 90 percent removal of total nitrogen (N) entering plant. Compliance with effluent objectives,
	Approximately 95 percent removal of total phosphorus (P) entering plant. Compliance with effluent objectives.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives.
	Compliance with all eefluent objectives.
Pesticides	Compliance with all receiving water objectives.
Metals	Compliance with all receiving water objectives.
	Compliance with all effluent objectives.

It is also anticipated that alternative R5A will result in 94 percent reduction in BOD, a 94 percent reduction in COD, a 98 percent reduc-

tion in suspended solids and a 100 percent reduction in ammonia as (N). After disinfection the effluent is expected to have a coliform level of 2.2/100 ml with a consistently high degree of virus removal.

Description of Construction. Alternative R5A, which involves high dose slaked lime chemical treatment, recarbonation, filtration, superchlorination and carbon adsorption plus existing plant and outfall improvements, includes the following sewage treatment construction:

1. Construction of improvements to the existing Richmond-Sunset plant as listed in items 1-10 and 13-17 under alternative R1, Report 1, Phase II.
2. Installation of chemical storage and feeding facilities as recommended in item 2, alternative R4B, Report 1, Phase II.
3. Installation of a sixth sedimentation tank as recommended in item 3, alternative R4B, Report 1, Phase II.
4. Installation of new preaeration flocculation facilities as recommended in item 4, alternative R4B, Report 1, Phase II.
5. Installation of preaeration flocculator recycling facilities as recommended in item 5, alternative R4B, Report 1, Phase II.
6. Installation of a sedimentation tank effluent control system as recommended in item 2, alternative R2, Report 1, Phase II plus the installation of a magnetic flow meter.
7. Installation of recarbonation facilities including fiberglass carbon dioxide storage tanks and equipment and apparatus required to introduce the gaseous CO_2 to the flow downstream from the sedimentation tank effluent control valves and upstream from the dual-media filters. The recarbonation system will be as recommended in item 6, alternative R4B, Report 1, Phase II, except that it will be provided with a total of 8-1/2 minutes of detention time.
8. Installation of eleven bifurcated dual-media filters each of which will have 800 sq ft of surface area. The filtration system will be installed downstream from the recarbonation facilities and will include air-water backwash facilities and automatic head loss and backwash controls. Backwash water will be provided by two pumps, each capable of providing one-half of a filter with 12 mgd effluent. It is anticipated that backwashing will require from 7 to 10 percent of the filtered effluent. A backwash holding tank will be provided to allow the backwashing to be pumped into the plant stream at a rate of flow which can be assimilated without upset. Backwashings will be discharged into the raw sewage flow upstream of the bar screens. Any 10 filters will be capable of handling the peak wet weather flow.
9. Modification of chlorination facilities including additional capacity for pre and superchlorination, installation of a prechlorination system, new chlorine handling pipelines, new superchlorination diffusers and control instrumentation. Chlorination capacity additions will be based on prechlorination (including allowances for bypass chlorination) at 3 mg/l Cl_2 for all flows and superchlorinating with 225 mg/l Cl_2 for flows up to approximately 45 mgd, and will consist of modifications of storage facilities to handle seven specially constructed aluminum semi-trailers each capable of hauling 7 one ton chlorine containers, 16 specially constructed aluminum trailers, three semi-tractors, covered storage facilities for nine semi-trailers and three semi-tractors and installation of 13 additional evaporator chlorinator combinations. Superchlorination chlorine vacuum piping will be designed to allow two units to standby for any of the other 11 superchlorination combinations. Two prechlorination evaporator-chlorinator combinations will be piped to supply chlorine under vacuum to either the prechlorination system of the bypass chlorination system.

Chlorine handling pipelines will be changed to handle chlorine gas under vacuum with the prechlorination, bypass chlorination and eleven superchlorination injectors located in the field at the point of application. New prechlorination injector will be located immediately north of the pretreatment structure and will be installed to maintain efficient application and mixing with a minimum of gaseous release. Superchlorination diffusers will be located immediately downstream from the dual-media filter head loss control valves. Each superchlorination diffuser will consist of a short pipe applicator followed immediately by an in-line, propeller type mixer. Each dif-

fuser will be capable of handling the complete output of an evaporator-chlorinator combination. Eleven injector water pumps will provide up to 350 gpm for each superchlorination injector. No 3 water will be used for the pre- and bypass chlorination injectors. Instrumentation signals and controls will be tied into the centralized control system.

10. Installation of a superchlorination contact chamber to provide six and one-half minutes of detention time at PWWF. Chamber will be designed in several compartments so that each may be taken out-of-service periodically for cleaning. Chamber design will minimize short circuiting, provide a positive head for superchlorination mixers and a positive suction head for each carbon adsorption system influent pump and each superchlorination injector water pump.

11. Installation of a carbon adsorption system complete with eight 30 ft diameter, 50 feet high carbon towers designed to provide 40 minutes of empty bed detention time at a downward application rate of 4 gpm/sq ft at ADWF with one standby tower, and sufficient hydraulic capacity to handle PWWF application; influent pumps; effluent collection and discharge chamber; and complete carbon regeneration facilities. Each tower will be provided with 410 tons of 16 x 40 mesh granular activated carbon, effluent and air backwash facilities, adequate space for bed expansion during backwash and facilities for draining and recharging the carbon bed and will be designed for a 50 psi working pressure.

Carbon adsorption influent pumps will be located in the superchlorination gallery and will provide the system with sufficient head to force the PWWF through the adsorption towers. Ten pumps will be provided with any 8 capable of handling the peak flow. All pumps will have variable speed electric drives and completely automatic controls.

A common effluent collection chamber will provide a suction supply for two 7 mgd backwash water pumps. It is anticipated that backwashing will require from 3 to 4 percent of the sorption effluent. Backwashing will be controlled by system head loss level. Backwashings will be collected in the filter backwashing holding tank and pumped back into the plant upstream of the primary sedimentation tanks. The collection chamber will also act as an effluent pumping station sump. Pumping station and gravity control valve operation will be similar to that described in item 12, alternative R1 Report 1, Phase II.

Carbon regeneration facilities will consist of transportation equipment, multiple hearth furnace regenerator, quench tank and carbon make-up storage and feeding equipment. Carbon will be regenerated at 1650° to 1700°F. Carbon regeneration will be controlled by COD removal efficiency. Carbon exhaustion is assumed to be 100 lbs carbon per 50 lbs COD removed with 7-1/2 percent make-up.

The complete carbon adsorption facilities will be housed in an enclosed structure with suitable ventilation and equipment access facilities and adequate noise and odor control. All flow and backwash controls will be automatic. Instrumentation signals and controls will be connected to the centralized control system.

In addition to these sewage treatment process improvements the following plant improvements should be made to the solids treatment and disposal facilities at the Richmond-Sunset plant:

12. Renovation of the 100 ft dia primary digester as recommended in item 7, alternative R4B, Report 1, Phase II.

13. Cleaning and renovation of the 80 ft dia secondary digester as recommended in item 8, alternative R4B, Report 1, Phase II.

14. Construction of new underground piping and conduit tunnel as recommended in item 10, alternative R1, Report 1, Phase II.

15. Enlargement of the existing sludge filtering system as recommended in item 10, alternative R4B, Report 1, Phase II plus a 3 percent allowance for increased solids.

16. Installation of vacuum filter filtrate electrolytic treatment facilities as recommended in item 11, alternative R4B, Report 1, Phase II plus a 3 percent allowance for increased solids.

17. Installation of two 80 dry tons per day, 22.25 ft dia, eight hearth incinerators with recalcining equipment, similar but 3 percent larger than the facilities recommended in item 12, alternative R4B, Report 1, Phase II.

Description of Operation. The high dose slaked lime chemical treatment process plus recarbonation, filtration, superchlorination, carbon adsorption and existing plant and outfall improvements proposed under alternative R5A will require more manpower than any of the other alternatives considered so far for the Richmond-Sunset plant. It is anticipated the calcium oxide handling and mixing equipment, recarbonation equipment, filtration and superchlorination equipment and carbon adsorption equipment will require the equivalent of four full-time maintenance operators in addition to the other personnel required for alternative R1, Report 1, Phse II. With continuous duty, these maintenance operator positions will entail the addition of at least 20 new personnel. In addition, it is expected that the increased sludge handling and disposal facilities will also require at least 5 new personnel.

Alternative R5A will require large amounts of power. Power use greater than that of alternative R1, Report 1, Phase II will result from the chemical handling facilities, underflow recycling, carbon dioxide diffusion, filter backwash, chlorine evaporation, chlorine diffusion, carbon adsorption pumping, adsorption tower backwash, regenerated carbon handling, additional solids filtering and the incineration and recalcining facilities. If the preaeration underflow recycling averages 10 percent of the plant flow, filter backwash 8-1/2 percent of the plant flow and carbon adsorption backwash 3-1/2 percent of the plant flow, it is estimated that the extra power over 1969-70 use will involve continuous running of approximately 3350 horsepower. Except for carbon regeneration and solids incineration fuel costs, other utility costs are expected to remain about the same as for alternative R1, Report 1, Phase II. Carbon regeneration utility costs, exclusive of power, are expected to average about $70/day. Incinerators are expected to use about 2320 therms/day of natural gas.

Influent and bypass chlorine use is expected to remain the same as alternative R1, Report 1, Phase II. Superchlorination chlorine requirements are expected to average about 220 mg/l, or 51,500 lbs/day. Salt requirements for odor control will be approximately 3000 lbs per day and it is estimated that with the use of 19 tons per day of recalcined lime, alternative R5A will require only 8 tons per day of new calcium oxide. Carbon dioxide use is expected to average about 7.2 tons per day and activated carbon make-up about 3.2 tons/day. No chemicals will be required for filter cake production.

Changes in maintenance and repair costs between alternatives R1, Report 1, Phase II and alternative R5A are expected to parallel the increased investment in equipment and facilities.

Screening and grit disposal costs are expected to be the same as alternative R4B, Report 1, Phase II. Incineration system is expected to produce an average of approximately 23 tons per day of damp ash (20 percent moisture) to be hauled to land fill disposal.

Estimated Construction Costs. Estimated construction costs, including engineering and contingencies for alternative R5A which provides for existing plant and outfall improvements plus high dose slaked lime chemical treatment, filtration, superchlorination and carbon adsorption are presented below. Costs are given for each item discussed in the preceding section and are based on 1971 prices.

Alternative R5A

Sewage Treatment		Solids Treatment	
1.	$ 9,911,000	12.	$ 390,000
2.	120,000	13.	165,000
3.	465,000	14.	120,000
4.	120,000	15.	464,000
5.	42,000	16.	324,000
6.	45,000	17.	4,187,000
7.	1,020,000		
8.	5,964,000	Subtotal	$ 5,650,000
9.	1,430,000	TOTAL	$34,987,000
10.	650,000		
11.	9,570,000		
Subtotal	$29,337,000		

The costs above do not include any allowance for the purchase of land required for structures for filtration, superchlorination or carbon adsorption. If all work must be completed by 1975, these costs should be increased by approximately 25 percent or $8,700,000.

Estimated Operation Costs. Estimated annual operating costs for existing plant and outfall improvements plus high dose lime chemical treatment with filtration, superchlorination and carbon adsorption are based on 1971 prices and are as follows:

	Alternative R5A
Labor	$ 858,000
Electric power	218,000
Other utilities	86,000
Chemicals	1,227,000
Maintenance, repair and supplies	97,000
Screening and grit disposal	----
Other solids disposal	38,000
Total	$ 2,524,000

Alternative R5B

A second combination of treatment processes which will improve effluent toxicity and nutrient levels involves combining the improved existing plant physical treatment facilities plus high dose slaked lime chemical treatment (Alternative R4B) with ammonia stripping, biological oxidation, filtration and carbon adsorption. Ammonia stripping operates best at high pH; therefore, for this combination recarbonation takes place after ammonia stripping.

It is anticipated that the solids production (not including chemical) under alternative R5B will be about 15 percent greater than that under alternative R4B. To compensate for the treatment of these solids, a 5 percent increase in the cost of solids removal, handling and disposal facilities of alternative R4B will be required. Previously built-in design tolerances limit the application of this cost increase to items 10, 11 and 12 of alternative R4B.

Reductions Expected. With the completion of all the proposed existing plant and outfall improvements and the installation of high dose slaked lime chemical treatment with ammonia stripping, recarbonation, biological oxidation, filtration and carbon adsorption it is expected that the following objectives can be attained at the Richmond-Sunset plant:

Alternative R5B

Parameter	Objective
Toxicity	Compliance with all receiving water objectives. Approximately 100 percent survival in effluent for 90 percent of the determinations. Compliance with effluent objectives.
Nutrients	Compliance with all receiving water objectives. Approximately 94 percent removal of total nitrogen (N) entering plant. Compliance with effluent objectives. Approximately 93 percent removal of total phosphorus (P) entering plant. Compliance with effluent objectives.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives. Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives.
Metals	Compliance with all receiving water objectives. Compliance with all effluent objectives.

It is also anticipated that alternative R5B will result in a 99 percent reduction in BOD, a 96 percent reduction in COD, a 99 percent reduction in suspended solids and a 91 percent reduction in ammonia as (N). After disinfection the effluent is expected to have a coliform level of 2.2/100 ml with a consistently high degree of virus removal.

Description of Construction. Alternative R5B, which involves high dose slaked lime chemical treatment, ammonia stripping, biological oxidation, filtration and carbon adsorption plus existing plant and outfall improvements, includes the following sewage treatment construction:

1. Construction of improvements to the existing Richmond-Sunset plant as listed in items 1-11 and 13-17, alternative R1, Report 1, Phase II.

2. Installation of chemical storage and feeding facilities as recommended in item 2, alternative R4B, Report 1, Phase II.

3. Installation of a sixth sedimentation tank as recommended in item 3, alternative R4B, Report 1, Phase II.

4. Installation of new preaeration flocculation facilities as recommended in item 4, alternative R4B, Report 1, Phase II.

5. Installation of preaeration flocculator recycling facilities as recommended in item 5, alternative R4B, Report 1, Phase II.

6. Installation of a sedimentation tank effluent control system with meter as recommended in item 6, alternative R5A.

7. Installation of six ammonia stripping towers each of which will be 75 feet long by 44 feet wide, have 24 feet of packing and be designed for a maximum hydraulic loading of 3 gpm/sq ft of PWWF. Ammonia stripping towers will be located immediately downstream from the primary sedimentation facilities and will include 4 variable speed, electric driven pumps, each of identical capacity, 3 of which will be capable of lifting PWWF to the top of the towers. Pump operation will be coordinated with the sedimentation tank effluent control system.

Sedimentation tank effluent will be introduced into distribution troughs at the top of the towers to insure even dispersion of the flow over the maximum formation of small water droplets and will consist of wood or plastic media. Design of the towers will be such that the packing may be easily removed for cleaning should scaling occur.

Large quantities of air, introduced at the bottom of each tower, will be swept up through the tower by airfoil type fans designed to provide 400 cu ft/gal at low noise level. Ammonia contained in the sedimentation tank effluent will be released from solution at the air-water interface and swept away by the air stream passing through the tower. Fog may be expected to occur in the tower air discharge whenever its dew point temperature is greater than the dew point temperature of the outside air. It is anticipated, however, that the plume will disipate rapidly. Although the efficiency of the ammonia stripping process is temperature dependent, it is believed mean temperatures at the Richmond-Sunset plant are sufficiently high to minimize the effects.

Ammonia stripping towers will be located immediately over the recarbonation tanks so that the flow will be returned to a stable pH of 8.5 as soon as possible. Sufficient space will be left between the tower air intake and recarbonation tanks to assure the complete dissipation of any excess free CO_2. No attempt will be made to precipitate calcium carbonate from the stripping tower effluent because the extremely low calcium and magnesium hardness results in a calcium loss of only 10 mg/l in the tower effluent. This balance is given in appendix A, Report 1, Phase II.

8. Installation of recarbonation facilities including fiberglas carbon dioxide storage tanks and equipment and apparatus required to introduce the gaseous CO_2 to the flow downstream from the stripping towers and upstream from the biological oxidation facilities. The recarbonation system will be as recommended in item 6, alternative R4B, Report 1, Phase II.

9. Installation of an activated sludge biological oxidation treatment system complete with aeration and secondary sedimentation facilities. The biological oxidation treatment system will be as recommended in item 3, alternative R4A, Report 1, Phase II except for the utilization of double concentric weirs for effluent collection.

10. Installation of eleven bifurcated dualmedia filters complete with backwash facilities as recommended in item 8, alternative R5A.

11. Installation of eight carbon adsorption towers complete with influent pumps, backwashing facilities, carbon regeneration facilities, effluent pumps, housing and controls as recommended in item 11, alternative R5A.

In addition to these sewage treatment process improvements, the following plant improvements should be made to the solids treatment and disposal facilities at the Richmond-Sunset plant:

12. Renovation of the 100 ft dia primary digester as recommended under item 7, alternative R4B, Report 1, Phase II. Waste activated sludge will be mixed with primary sludge prior to its introduction to the gravity thickener.

13. Cleaning and renovation of the 80 ft dia secondary digester as recommended in item 8, alternative R4B, Report 1, Phase II.

14. Construction of new underground piping and conduit tunnel as recommended in item 10, alternative R1, Report 1, Phase II.

15. Enlargement of the existing sludge filtering system as recommended in item 10, alternative R4B, Report 1, Phase II plus a 5 percent allowance for increased solids.

16. Installation of vacuum filter filtrate electrolytic treatment facilities as recommended in item 11, alternative R4B, Report 1, Phase II plus a 5 percent allowance for increased solids.

17. Installation of two 81 dry tons per day, 22.25 ft dia, eight hearth incinerators with recalcining equipment, all similar but 5 percent larger than the facilities recommended in item 12, alternative R4B, Report 1, Phase II.

Description of Operation. The high dose slaked lime chemical treatment process plus ammonia stripping, recarbonation, biological oxidation, filtration, carbon adsorption and existing plant and outfall improvements proposed under alternative R5B will require even more manpower than alternative R5A. It is anticipated the calcium oxide handling and mixing equipment, ammonia stripping pumps and towers, recarbonation equipment, biological oxidation and filtration facilities, carbon adsorption equipment and effluent pumps will require the equivalent of five full-time maintenance operators in addition to the other personnel required for alternative R1, Report 1, Phase II. With continuous duty, these maintenance operator positions will entail the addition of at least 25 new personnel. In addition, it is expected that the increased sludge handling and disposal facilities will require at least 6 new personnel.

Alternative R5B will require greater amounts of power than alternative R5A. Power use greater than that of alternative R1, Report 1, Phase II will result from the chemical handling facilities, underflow recycling, ammonia stripping pumping and air blowers, carbon dioxide diffusion, aeration and agitation air blowers, return activated sludge pumps, secondary sedimentation tank drives, filter backwash pumping, carbon adsorption pumping, adsorption tower backwash pumping, regenerated carbon handling, additional solids filtering and the incineration and recalcining facilities. If the preaeration underflow recycling, return activated sludge pumping, filter backwash pumping and carbon adsorption backwash pumping average 10, 25, 8-1/2 and 3-1/2 percent, respectively, of plant flow, it is estimated that the extra power over 1969-70 use will involve the continuous running of approximately 4200 horsepower. Except for carbon regeneration and solids incineration fuel costs, other utility costs are expected to remain about the same as for alternative R1, Report 1, Phase II. Carbon regeneration utility costs, exclusive of power, are expected to average about $70/day. Incinerators are expected to use about 2,360 therms/day of natural gas.

Influent and bypass chlorine use is expected to remain the same as alternative R1, Report 1, Phase II. Chlorine use for effluent disinfection will be similar to that indicated for alternative R4A, Report 1, Phase II. Salt requirements for odor control will be approximately 3000 lbs per day and it is estimated that with the use of 19 tons per day of recalcined lime, alternative R5B will require only 8 tons per day of new calcium oxide. Carbon dioxide use is expected to average about 7.2 tons per day and activated carbon make-up about 0.87 tons/day. No chemicals will be required for filter cake production.

Changes in maintenance and repair costs between alternatives R1, Report 1, Phase II and alternative R5B are expected to parallel the increased investment in equipment and facilities.

Screnning and grit disposal costs are expected to be the same as alternative R4B, Report 1, Phase II. Incineration system is expected to produce an average of approximately 24 tons per day of damp ash (20 percent moisture) to be hauled to land fill disposal.

Estimated Construction Costs. Estimated construction costs, including engineering and contingencies, for alternative R5B which provides for existing plant and outfall improvements plus high dose slaked lime chemical treatment, ammonia stripping, recarbonation, biological oxidation, filtration and carbon adsorption are presented below. Costs are given for each item discussed in the preceding section and are based on 1971 prices.

Alternative R5B

Sewage Treatment		Solids Treatment	
1.	$ 9,989,000	12.	$ 390,000
2.	120,000	13.	165,000
3.	465,000	14.	120,000
4.	120,000	15.	472,000
5.	42,000	16.	331,000
6.	45,000	17.	4,168,000
7.	3,750,000	Subtotal	$ 5,646,000
8.	420,000		
9.	8,100,000	TOTAL	$44,231,000
10.	5,964,000		
11.	9,570,000		
Subtotal	$38,585,000		

The costs above do not include any allowance for the purchase of land required for structures for ammonia stripping, biological oxidation, filtration or carbon adsorption. If all work must be completed by 1975, these costs should be increased by approximately 25 percent or $11,000,000.

Estimated Operation Costs. Estimated annual operating costs for existing plant and outfall improvements plus high dose lime chemical treatment with ammonia stripping, recarbonation, biological oxidation, filtration and carbon adsorption are based on 1971 prices and are as follows:

	Alternative R5B
Labor	$ 975,000
Electric power	275,000
Other utilities	86,000
Chemicals	325,000
Maintenance, repairs and supplies	112,000
Screening and grit disposal	----
Other solids disposal	39,000
Total	$ 1,794,000

Alternative R5C

A third combination of treatment processes which will improve effluent toxicity and nutrient levels involves combining the improved existing plant physical treatment facilities with biological oxidation to nitrification, denitrification with chemical addition, filtration and carbon adsorption. This alternative utilizes biological treatment to its fullest extent and relies on chemical addition only as required to assure phosphorus removal. It is anticipated that this system will result in a 20 percent increase in solids generation, including chemicals, over the biological treatment system of alternative R4A, Report 1, Phase II.

Because of this increased loading and the chemical additions, solids treatment for alternative R5C will differ from alternative R4A. Waste activated and denitrification sludges are expected to increase the flotation thickener surface area requirements to 1000 sq ft at a loading rate of 25 lbs/sq ft and the digester loading to 0.130 lbs/sq ft/day with a 21.5 day detention. Digested sludge production will be approximately 48,000 gpd of 6 percent solids. Heat treatment conditioning will be utilized to increase the dewaterability of the sludge. Maximum heat conditioning requirements will be approximately 5,000 gph. With heat treatment conditioning, the existing filters will be expected to operate at a loading rate of 10 lbs (day)/sq ft/hr and produce a 35 percent solids filter cake. Maximum supernatant, heat treatment decant and filtrate production will be 10,000 gph.

Reductions Expected. With the completion of all the proposed existing plant and outfall improvements and the installation of biological oxidation to nitrification, denitrification with chemical addition, filtration and carbon adsorption, it is expected that the following objectives can be attained at the Richmond-Sunset plant:

Alternative R5C

Parameter	Objective
Toxicity	Compliance with all receiving water objectives. Approximately 100 percent survival in effluent for 90 percent of the determinations. Compliance with effluent objectives.
Nutrients	Compliance with all receiving water objectives. Approximately 94 percent removal of total nitrogen (N) entering plant. Compliance with effluent objectives. Approximately 99 percent removal of total phosphorus (P) entering plant. Compliance with effluent objectives.

Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives.
	Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives.
Metals	Compliance with all receiving water objectives.
	Compliance with all effluent objectives.

It is also anticipated that alternative R5C will result in a 99 percent reduction in BOD, a 97 percent reduction in COD, a 99 percent reduction in suspended solids and a 95 percent reduction in ammonia as (N). After disinfection the effluent is expected to have a coliform level of 2.2/100 ml with a consistently high degree of virus removal.

Description of Construction. Alternative R5C, which involves biological oxidation to nitrification, denitrification with chemical addition, filtration and carbon adsorption plus existing plant and outfall improvements, includes the following sewage treatment construction:

1. Construction of improvements to the existing Richmond-Sunset plant as listed in items 1-11 and 13-17, alternative R1, Report 1, Phase II.
2. Installation of a sedimentation tank effluent control system with meter as recommended in item 6, alternative R5A.
3. Installation of an activated sludge biological oxidation treatment system complete with nitrifying aeration facilities and secondary sedimentation tanks. The biological oxidation treatment system will be similar to the system described in item 3, alternative R4A, Report 1, Phase II except for the doubling of the tank capacity to accommodate the 25 percent increase in blower capacity to maintain an aeration air rate of 1800 cu ft per lb of BOD removed and the utilization of double concentric weirs for effluent collection.
4. Installation of a denitrification system complete with two denitrification tanks and four circular final sedimentation tanks. Each denitrification tank will be approximately 140 feet long, 50 ft wide and 15 ft deep, and will be divided by curtain walls into compartments as required for proper mixing and stirring. At ADWF the detention time in the tanks will be about 78 minutes. Tank sizing assumes a volatile mixed liquor concentration of 2100 mg/l and utilizes a loading rate of 0.2 lbs nitrate as N/day/lb MLVSS.

Nitrified effluent from the secondary sedimentation tanks will be mixed with return sludge in a channel ahead of the denitrifying tanks. As the mixed liquor passes through the tank it will be constantly stirred and mixed to keep all solids in suspension. Methanol will be added at the beginning of each tank and immediately mixed with the nitrified influent and returned sludge. Provisions will also be included to add methanol along each tank. Methanol addition will be at the rate of 3.2 lbs/lb of applied nitrate as N. During denitrification nitrates are reduced to nitrogen gas. Mixed liquor from the denitrification tanks will be discharged to the final sedimentation tanks by open channel where mixing and agitation will be provided to keep the solids in suspension and to scrub the nitrogen gas from the liquid. Alum will be added to the mixed liquor just upstream of the final sedimentation tanks for removal of phosphorus and provisions will be included for final pH adjustment. It is anticipated the average active alumina (Al_2O_3) rate of application will be 32 mg/l. This coincides to an Al/P ratio of 1.4/1. Provisions will be made for feeding at a peak rate of 45 mg/l[9].

Final sedimentation will take place in four circular reinforced concrete tanks. Each tank will have a diameter of 120 ft and a side water depth of 20 ft. Any three tanks will be able to handle the PWWF with an overflow rate of 2000 gal per sq ft per day. The tanks will be arranged in a single battery of four fed from the denitrifying mixed liquor channel by a single center channel. The influent and discharge hydraulic losses at the final sedimentation tanks will be carefully balanced to insure that all tanks perform equally at all conditions of flow.

Mixed liquor will be introduced at the center of the tanks through a baffling structure, and effluent collected by double concentric weirs arranged to provide maximum solids removal efficiency. Sludge will be continuously removed by a rotating hollow tube fitted with orifices and a squeegee. The rate of sludge

withdrawal will be controlled in response to signals from automatic sensors to maintain the sludge blanket at a preset level. Sludge will be withdrawn by self-priming nonclog pumps and discharged to the sludge return channel of the denitrification tanks. Convenient means will be provided for sampling and visual observation of the sludge. Excess denitrifying slude, if any, will be wasted through a meter directly to the waste activated sludge flotation thickening tanks.

Automatic skimming will be provided on each final sedimentation tank with the scum removed directly to ejectors for discharge to the waste activated sludge force main. Effluent from the final sedimentation tanks will be discharged via closed channels directly to the dual-media filters.

All of the denitrification treatment facilities will be uncovered. All instrumentation signals and controls will be transmitted to the centralized control center.

5. Installation of eleven bifurcated dual-media filters complete with backwash facilities as recommended in item 8, alternative R5A.

6. Installation of eight carbon adsorption towers complete with influent pumps, backwashing facilities, carbon regeneration facilities, effluent pumps, housing and controls as recommended in item 11, alternative R5A.

In addition to these sewage treatment process improvements the following plant improvements should be made to the solids treatment and disposal facilities at the Richmond-Sunset plant:

7. Installation of at least two air flotation thickening units to provide 2000 sq ft of tank surface including adequate stand-by. Each tank will be provided with top scum and bottom sludge collection and removal equipment, sufficient settled sewage and compressed air dissolving equipment, and adequate automatic controls. Tanks will be completely housed and provided with positive ventilation and odor control equipment. Thickener overflow will be directed to the primary sedimentation tank influent.

8. Construction of improvements to the existing Richmond-Sunset plant solids treatment and disposal facilities as listed in items 18-21 and 23, alternative R1, Report 1, Phase II with the electrolytic wastewater treatment process for digester supernatant, heat conditioning decant and filtrate increased in capacity to 10,000 gph.

9. Installation of sludge heat conditioning facilities, including solids disintegration, heat exchangers, pumps, control valves, reactor vessels, treated sludge storage and decanting tank, pressure ventilation and deodorization, and necessary controls. Facilities will have a capacity of 3000 gph.

Description of Operation. The biological oxidation treatment process with nitrification, denitrification with chemical addition, filtration, carbon adsorption and existing plant and outfall improvements proposed under alternative R5C will require the same amount of manpower required by alternative R5A. It is anticipated the biological nutrification and denitrification facilities, filtration facilities, carbon adsorption equipment, effluent pumps and waste activated sludge flotation thickening facilities will require the equivalent of five full-time maintenance operators in addition to the other personnel required for alternative R1, Report 1, Phase II. With continuous duty, these maintenance operator positions will entail the addition of at least 25 new personnel.

Alternative R5C will require the greatest amount of power of all alternatives. The extra power use will result from the aeration and agitation air blowers and return activated sludge pumps of the biological oxidation system with nitrification, the agitation air blowers and return activated sludge pumps of the denitrification system, the intermediate and final sedimentation tank drives, the waste sludge pumps of both systems, the filter backwash pumping, the carbon adsorption pumping, the adsorption tower backwash pumping, the regenerated carbon handling, the flotation thickener pumps, compressors and ventilating and deodorizing equipment, the heat conditioning equipment and the larger electrolytic treatment facilities. If the return activated sludge pumping in both systems, the filter backwash pumping and the carbon adsorption backwash pumping average 25, 8-1/2 and 3-1/2 percent, respectively, of plant flow, it is estimated that the extra power over 1969-70 use will involve the continuous running of approximately 4500 horsepower. Except for carbon regeneration fuel costs, other utility costs are expected to remain about the same as

for alternative R1, Report 1, Phase II. Carbon regeneration utility costs, exclusive of power, are expected to average about $70/day.

Influent and bypass chlorine use is expected to remain the same as alternative R1, Report 1, Phase II. Chlorine use for effluent disinfection will be similar to that indicated for alternative R4A, Report 1, Phase II. Salt requirements for odor control will be approximately 6000 lbs per day. Activated carbon make-up will average about 0.80 tons/day, methanol use about 2600 gal/day, and liquid alum for phosphorus removal about 45 tons/day, No chemicals will be required for filter cake production.

Changes in maintenance and repair costs between alternatives R1, Report 1, Phase II and alternative R5C are expected to parallel the increased investment in equipment and facilities.

Screening and grit disposal costs are expected to be the same as alternative R1, Report 1, Phase II. It is anticipated that alternative R5C will require the filters to be operated approximately 10 hours per day, five days per week. Filter cake production, when prorated to a continuous basis, will average 41.5 tons per day, 9 tons per day above the park utilization capacity.

Estimated Construction Costs. Estimated construction costs, including engineering and contingencies, for alternative R5C which provides for existing plant and outfall improvements plus biological oxidation with nitrification, denitrification with chemical addition, filtration and carbon adsorption are presented below. Costs are given for each item discussed in the preceding section and are based on 1971 prices.

Alternative R5C

Sewage Treatment		Solids Treatment	
1.	$ 9,989,000	7.	$ 390,000
2.	45,000	8.	1,103,000
3. 4.	11,250,000	9.	1,095,000
5.	5,964,000	Subtotal	$ 2,588,000
6.	9,570,000	TOTAL	$39,406,000
Subtotal	$36,818,000		

The costs above do not include any allowance for the purchase of land required for structures for biological oxidation to nitrification, denitrification with chemical addition, filtration or carbon adsorption. If all work must be completed by 1975, these costs should be increased by approximately 25 percent or $9,900,000.

Estimated Operation Costs. Estimated annual operating costs for existing plant and outfall improvements plus biological oxidation with nitrification, denitrification with chemical addition, filtration and carbon adsorption are based on 1971 prices and are as follows:

Alternative R5C

Labor	$ 858,000
Electric power	294,000
Other utilities	26,000
Chemicals	837,000
Maintenance, repair and supplies	100,000
Screening and grit disposal	13,000
Other solids disposal	15,000
Total	$2,143,000

Summary

Table 3-3 presents the predicted plant performance for the Richmond-Sunset plant. Table 3-4 summarizes estimated construction and operating costs of the alternatives.

SOUTHEAST WATER POLLUTION CONTROL PLANT

Review of the results of the three alternatives studied for the Richmond-Sunset plant indicates that, as long as sufficient land area is available, the alterantive utilizing biological oxidation to nitrification, denitrification with chemical addition, filtration and carbon adsorption will probably provide the most economical means of attaining the highest goals for Southeast effluent toxicity and nutrient content. The susceptibility of this biological treatment to toxic upset, however, indicates the advisability of also investigating the physical chemical process which utilizes high lime chemical treatment, recarbonation, super-

Table 3 - 3

Predicted Performance of Alternative Treatment Processes
Richmond-Sunset Water Pollution Control Plant

Alternative	Toxicity		Nutrients			Phenols	Sulfides	
	Percent 96-hr TLm conc wastes in rec water	Percent survival in effluent 90 percent of time	Rec water chlorophyll level mg/l	Percent removal total N in influent	Percent removal total P in influent	Rec water conc mg/l	Rec water conc mg/l	Effluent conc mg/l
R1	<10[b]	10[a]	<10[b]	10[a]	10[a]	<0.03[b]	<0.05[b]	<0.1[b]
R2	< 5[b]	15[a]	<10[b]	10[a]	20[a]	<0.03[b]	<0.05[b]	<0.1[b]
R3	< 5[b]	25[a]	<10[b]	15[a]	50[a]	<0.03[b]	<0.05[b]	<0.1[b]
R4A	< 5[b]	30[a]	<10[b]	30[a]	35[a]	<0.03[b]	<0.05[b]	<0.1[b]
R4B	< 5[b]	40[a]	<10[b]	20[a]	85[a]	<0.03[b]	<0.05[b]	<0.1[b]
R5A	< 5[b]	90[b]	<10[b]	92[b]	93[b]	<0.03[b]	<0.05[b]	<0.1[b]
R5B	< 5[b]	100[b]	<10[b]	94[b]	93[b]	<0.03[b]	<0.05[b]	<0.1[b]
R5C	< 5[b]	100[b]	<10[b]	94[b]	99[b]	<0.03[b]	<0.05[b]	<0.1[b]

Alternative	Pesticides — Receiving water concentrations				Metals — Receiving water concentrations				
	Lindane µg/l	Heptachlor epoxide µg/l	D.D.T. (incl D.D.E. and D.D.D.) µg/l	Dieldrin µg/l	Hexavalent chromium mg/l	Total chromium mg/l	Lead mg/l	Copper mg/l	Zinc mg/l
R1	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
R2	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
R3	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
R4A	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
R4B	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
R5A	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
R5B	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
R5C	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]

Alternative	Effluent concentrations									
	Cadmium mg/l	Aluminum mg/l	Total chromium mg/l	Copper mg/l	Zinc mg/l	Iron mg/l	Nickel mg/l	Lead mg/l	Mercury mg/l	Aresnic mg/l
R1	0.03	1.5[a]	<1.0[b]	.05[a]	<1.0[b]	<1.0[b]	<5.0[b]	<0.05[b]	0.035	<3.0[b]
R2	0.03	1.5[a]	<1.0[b]	<0.05[b]	<1.0[b]	<1.0[b]	<5.0[b]	<0.05[b]	0.035	<3.0[b]
R3	0.01	1.0[a]	<1.0[b]	<0.05[b]	<1.0[b]	<1.0[b]	<5.0[b]	<0.05[b]	0.010	<3.0[b]
R4A	0.02	1.0[a]	<1.0[b]	<0.05[b]	<1.0[b]	<1.0[b]	<5.0[b]	<0.05[b]	0.035	<3.0[b]
R4B	<0.01[b]	<1.0[b]	<1.0[b]	<0.05[b]	<1.0[b]	<1.0[b]	<5.0[b]	<0.05[b]	<0.005[b]	<3.0[b]
R5A	<0.01[b]	<1.0[b]	<1.0[b]	<0.05[b]	<1.0[b]	<1.0[b]	<5.0[b]	<0.05[b]	<0.005[b]	<3.0[b]
R5B	<0.01[b]	<1.0[b]	<1.0[b]	<0.05[b]	<1.0[b]	<1.0[b]	<5.0[b]	<0.05[b]	<0.005[b]	<3.0[b]
R5C	<0.01[b]	<1.0[b]	<1.0[b]	<0.05[b]	<1.0[b]	<1.0[b]	<5.0[b]	<0.05[b]	<0.005[b]	<3.0[b]

[a] Meets minimum stipulated objective.

[b] Meets maximum stipulated objective.

Table 3 - 4

Estimated Construction and Operating Costs of Alternative Treatment Processes Richmond-Sunset Water Pollution Control Plant

Alternative	Estimated construction cost, dollars[a]	Estimated annual operating cost, dollars
R1	11,831,000	682,000
R2	14,751,000	789,000
R3	13,657,000	798,000
R4A	20,211,000	893,000
R4B	17,561,000	1,078,000
R5A	34,987,000	2,524,000
R5B	44,231,000	1,794,000
R5C	39,406,000	2,143,000

[a]No land costs included. See appendix D for additional land area required for each alternative.

chlorination, filtration and carbon adsorption. The following eight alternatives, including the six previously reviewed for Report 1, Phase II, were selected for economic analysis:

Alternative	**Description**
S1-S4B	Same descriptions as provided in Chapter 6 of Report 1, Phase II.
S5A	Existing plant, effluent pumping station and outfall improvements plus chemical treatment with high dose slaked lime (450-550 mg/l) added ahead of primary sedimentation, recarbonation, filtration superchlorination and carbon adsorption.
S5B	Existing plant, effluent pumping station and outfall improvements plus biological oxidation to nitrification, denitrification with chemical addition, filtration and carbon adsorption.

All alternatives were analyzed on the basis of the following basic loading factors:

ADWF	36 mgd
PWWF	70 mgd
BOD	273 mg/l
COD	800 mg/l
TSS	420 mg/l
Ammonia, as N	17 mg/l
Total nitrogen, as N	49 mg/l
Phosphorus, as P	15 mg/l

Carbon adsorption is provided to assure that the nondegradable organics assumed to be present in the industrial wastes tributary to the Southeast plant are removed sufficiently to meet effluent toxicity goals. In addition, it is assumed that sufficient excess capacity exists, or is provided, under all alternatives to assimilate toxic, nutrient and hydraulic loadings in the liquid return from the solids treatment process. In the Southeast plant this includes the thickener overflow and filtrate from the North Point solids treatment facilities as well as the Southeast facilities.

Alternative S1

Alternative S1 involves modifications to the Southeast sewage and solids treatment facilities, including improvements to the effluent pumping station and the deep water outfall to improve existing treatment efficiency and reliability.

Reductions Expected. Upon completion of all the proposed existing plant effluent, pumping station and outfall improvements, it is expected that the following objectives can be attained at the Southeast plant:

Alternative S1

Parameter	Objectives
Toxicity	Approximately 4 percent of the 96-hour TLm concentration of waste as discharged within one foot of the surface of the receiving water. Compliance with all objectives. Approximately 10 percent survival in effluent for 90 percent of the determinations.
Nutrients	Less than 50 mg/l chlorophyll in receiving water. Compliance with all objectives. Approximately 10 percent removal of total nitrogen (N) entering plant. Approxiamtely 10 percent removal of total phosphorus (P) entering plant.
Phenols	Less than 0.03 mg/l in the receiving water. Compliance with all objectives.
Sulfides	Less than 0.05 mg/l in the receiving water. Compliance with all objectives. Less than 0.1 mg/l in the effluent. Compliance with all objectives.
Pesticides	Less than 0.002 μg/l Lindane, 0.002 μg/l Heptachlorepoxide and 0.003 μg/l Dieldrin in the receiving water. Compliance with all objectives. Approximately 0.010 μg/l D.D.T (including D.D.E and D.D.D.) in the receiving water.
Metals	Less than 0.5 mg/l hexavalent chromium, 0.25 mg/l lead, 0.05 mg/l copper and 0.1 mg/l zinc in the receiving water. Complaince with all objectives. Less than 0.05 mg/l lead, 1.0 mg/l zinc, 5.0 mg/l nickel and 3.0 mg/l arsenic in the effluent. Compliance with all objectives. Approximately 5.0 mg/l aluminum in the effluent. Approximately 4.0 mg/l total chromium in the effluent. Approximately 0.35 mg/l copper in the effluent. Approximately 2.5 mg/l iron in the effluent. Approximately 0.200 mg/l mercury in the effluent.

It is also anticipated that alternative S1 will result in a 35 percent reduction of BOD and COD, a 65 percent reduction in suspended solids and no significant reduction of ammonia as N. After disinfection the effluent is expected to have a coliform level of 1000/100 ml with relatively little virus removal.

Description of Construction. Existing plant improvements include the 23 items of construction described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, Phase II.

Estimated Construction Costs. Detailed breakdown of the estimated construction costs by items is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative S1 is $7,602,000.

Estimated Operation Costs. Detailed breakdown of the estimated annual operating costs for alternative S1 is given in Chapter 6, Report 1, Phase II. Total estimated annual operating cost is $1,134,000.

Alternative S2A

Alternative S2A involves the existing plant, effluent pumping station, and outfall improvements of alternative S1 combined with dissolved air flotation of the settled sewage. This alternative is the only completely physical treatment process combination which will improve plant effluent quality.

Reductions Expected. Upon completion of all existing plant, effluent pumping station and outfall improvements and the installation of dissolved air flotation, it is expected that the following objectives can be attained at the Southeast plant:

Alternative S2A

Parameter	Objectives
Toxicity	Compliance with all receiving water objectives. Approximately 15 percent survival in the effluent for 90 percent of the determinations.
Nutrients	Compliance with all receiving water objectives. Approximately 10 percent removal of total nitrogen (N) entering plant. Approximately 20 percent removal of total phosphorus (P) entering plant.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives. Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives for Lindane, Heptachlor-epoxide and Dieldrin. Approximately 0.010 μg/l D.D.T. (including D.D.E. and D.D.D.) in the receiving water.
Metals	Compliance with all receiving water objectives. Compliance with effluent objectives for lead, zinc, nickel and arsenic. Approximately 4.5 mg/l aluminum in the effluent. Approximately 3.5 mg/l total chromium in the effluent. Approximately 0.30 mg/l copper in the effluent. Approximately 2.5 mg/l iron in the effluent. Approximately 0.200 mg/l mercury in the effluent.

It is also anticipated that alternative S2A will result in a 40 percent reduction of BOD and COD, a 78 percent reduction in suspended solids and no significant reduction in ammonia as N. After disinfection the effluent is expected to have a coliform level of 1000/100 ml with relatively little virus removal.

Description of Construction. Dissolved air flotation and existing plant, effluent pumping station and outfall improvements include the 24 items of construction described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, Phase II.

Estimated Construction Costs. Detailed breakdown of the estimated construction costs by items is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative S2A is $10,793,000.

Estimated Operation Costs. Detailed breakdown of the estimated annual operating costs for alternative S2A is given in Chapter 6 of Report 1, Phase II. Total estimated annual operating cost is $1,311,000.

Alternative S2B

Alternative S2B involves the existing plant, effluent pumping station and outfall improvements of alternative S1 combined with a low dose ferric chloride chemical treatment of 15-45 mg/l $FeCl_3$, 1200-1500 mg/l NaCl, and 0.25 mg/l polymer. The polymer is added only during the 12 hour peak flow period each day and all chemical addition is eliminated during periods of PWWF.

Reductions Expected. Upon completion of all existing plant, effluent pumping station and outfall improvements and the installation of the low dose ferric chloride chemical treatment facilities, it is expected that the following objectives can be attained at the Southeast plant:

Alternative S2B

Parameter	Objectives
Toxicity	Compliance with all receiving water objectives. Approximately 25 percent survival in effluent for 90 percent of the determinations.

Nutrients	Compliance with all receiving water objectives. Approximately 15 percent removal of total nitrogen (N) entering plant. Approximately 50 percent removal of total phosphorus (P) entering plant.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives. Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives.
Pesticides	Compliance with all receiving water objectives for Lindane, Heptachlor-epoxide and Dieldrin, Dieldrin. Approximately 0.010 μg/l D.D.T. (including D.D.E. and D.D.D.) in the receiving water.
Metals	Compliance with all receiving water objectives. Compliance with effluent objectives for lead, zinc, iron, nickel and arsenic. Approximately 3.0 mg/l aluminum in the effluent. Approximately 2.5 mg/l total chromium in the effluent. Approximately 0.20 mg/l copper in the effluent. Approximately 1.5 mg/l iron in the effluent. Approximately 0.050 mg/l mercury in the effluent.

It is also anticipated that alternative S2B will result in a 40 percent reduction of BOD and COD, a 75 percent reduction in suspended solids and no significant reduction in ammonia as N. After disinfection the effluent is expected to have a coliform level of 1000/100 ml with relatively little virus removal.

Description of Construction. Low dose ferric chloride chemical treatment and existing plant, effluent pumping station and outfall improvement include the 26 items of construction described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, Phase II.

Estimated Construction Costs. Detailed breakdown of the estimated construction costs by items is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative S2B is $10,448,000.

Estimated Operation Costs. Detailed breakdown of the estimated annual operating cost for alternative S2B is given in Chapter 6 of Report 1, Phase II. Total estimated annual operating cost is $1,240,000.

Alternative S3

Alternative S3 involves the existing plant, effluent pumping station and outfall improvements of alternative S1 combined with biological oxidation (activated sludge) treatment of the settled sewage. Only oxidation of carbonaceous matter will be achieved at the loading of 50 lbs BOD/1000 cu ft tank volume utilized in this alternative.

Reductions Expected. Upon completion of all existing plant, effluent pumping station and outfall improvements and the installation of activated sludge biological treatment, it is expected that the following objectives can be attained at the Southeast plant:

Alternative S3

Parameter	Objectives
Toxicity	Compliance with all receiving water objectives. Approximately 30 percent survival in effluent for 90 percent of the determinations.
Nutrients	Compliance with all receiving water objectives. Approximately 30 percent removal of total nitrogen (N) entering plant. Approximately 35 percent removal of total phosphorus (P) entering plant.
Phenols	Compliance with all receiving water objectives. Compliance with all effluent objectives.

Sulfides	Compliance with all receiving water objectives.
	Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives for Lindane, Heptachlor-epoxide and Dieldrin.
	Approximately 0.010 μg/l D.D.T. (including D.D.E and D.D.D.) in the receiving water.
Metals	Complaince with all receiving water objectives.
	Compliance with effluent objectives for lead, zinc, nickel and arsenic.
	Approximately 2.5 mg/l aluminum in the effluent.
	Approximately 2.0 mg/l total chromium in the effluent.
	Approximately 0.15 mg/l copper in the effluent.
	Approximately 2.0 mg/l iron in the effluent.
	Approximately 0.100 mg/l mercury on the effluent.

It is also anticipated that alternative S3 will result in a 90 percent reduction in BOD, an 80 percent reduction in COD, an 87-1/2 percent reduction in suspended solids and about a 10 percent reduction in ammonia as N. After disinfection the effluent is expected to have a coliform level of 240/100 ml with relatively little virus removal.

Description of Construction. Activated sludge biological treatment and existing plant, effluent pumping station and outfall improvements include the 24 items of construction described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, Phase II.

Estimated Construction Costs. Detailed breakdown of the estimated construction costs by items is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative S3 is $18,858,000.

Estimated Operation Costs. Detailed breakdown of the estimated annual operating costs for alternative S3 is given in Chapter 6 of Report 1, Phase II. Total estimated annual operating cost is $1,485,000.

Alternative S4A

Alternative S4A involves the existing plant, effluent pumping station and outfall improvement of alternative S1 combined with a high dose slaked lime chemical treatment of 450 to 550 mg/l $Ca(OH)_2$ with recycling of up to 25 percent of ADWF. The large quantities of solids produced by this alternative will be incinerated.

Reductions Expected. Upon completion of all existing plant, effluent pumping station and outfall improvements and the installation of the high dose slaked lime chemical treatment facilities, it is expected that the following objectives can be attained at the Southeast plant:

Alternative S4A

Parameter	Objectives
Toxicity	Compliance with all receiving water objectives.
	Approximately 40 percent survival in effluent for 90 percent of the determinations.
Nutrients	Compliance with all receiving water objectives.
	Approximately 20 percent removal of total nitrogen (N) entering plant.
	Approximately 85 percent removal of total phosphorus (P) entering plant.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving Water objectives.
	Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives for Lindane, Heptachlor-epoxide and Dieldrin.
	Approxiamtely 0.010 mg/l D.D.T. (including D.D.E. and D.D.D.) in the receiving water.
Metals	Compliance with all receiving water objectives.
	Compliance with all effluent objectives for lead, zinc, nickel and arsenic.
	Less than 0.01 mg/l cadmium, 1.0 mg/l aluminum, 1.0 mg/l total chromium, 0.05 mg/l copper, 1.0 mg/l iron, and 0.005 mg/l mercury in the effluent. Compliance with effluent objectives.

It is also anticipated that alternative S4A will result in a 70 percent BOD reduction, a 60 percent COD reduction, an 87-1/2 percent suspended solids reduction and no significant reduction in ammonia as N. After disinfection the effluent is expected to have a coliform level of 240/100 ml with a moderate degree of virus removal.

Description of Construction. High dose slaked lime chemical treatment and existing plant, effluent pumping station and outfall improvements include the 26 items of construction described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, Phase II.

Estimated Construction Costs. Detailed breakdown of estimated construction cost by items is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative S4A is $13,543,000.

Estimated Operation Costs. Detailed breakdown of estimated annual operating costs for alternative S4A is given in Chapter 6 of Report 1, Phase II. Total estimated annual operating costs are $2,014,000.

Alternative S4B

Alternative S4B involves the existing plant, effluent pumping station and outfall improvement of alternative S1 combined with high dose ferric chloride chemical treatment of 100-150 mg/l $FeCl_3$, 1200-1500 mg/l NaCl and 0.50 mg/l polymer and filtration. Flotation sludge thickeners and existing digesters will be used to handle the large quantities of solids produced by this alternative.

Reductions Expected. Upon completion of all existing plant, effluent pumping station and outfall improvements and the installation of high dose ferric chloride chemical treatment with filtration, it is expected that the following objectives can be attained at the Southeast plant:

Alternative S4B

Parameter	Objectives
Toxicity	Compliance with all receiving water objectives, Approximately 30 percent survival in effluent for 90 percent of the determinations.
Nutrients	Compliance with all receiving water objectives. Approximately 20 percent removal of total nitrogen (N) entering plant. Approximately 85 percent removal of total phosphorus (P) entering plant.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives. Compliance with all effluent objectives.
Pesticides	Compliance with all receiving water objectives for Lindane, Heptachlor-epoxide and Dieldrin. Approximately 0.010 μg/l D.D.T. (including D.D.E. and D.D.D.) in the receiving water.
Metals	Compliance with all receiving water objectives. Compliance with all effluent objectives.

It is also anticipated that alternative S4B will result in a 65 percent BOD reduction, a 60 percent COD reduction, an 87-1/2 percent suspended solids reduction and no significant reduction in ammonia as N. After disinfection the effluent is expected to have a coliform level of 240/100 ml with a moderate degree of virus removal.

Description of Construction. High dose ferric chloride chemical treatment with filtration and existing plant, effluent pumping station and outfall improvements includes the 30 items of construction described in Chapter 6 of Report 1, Phase II.

Description of Operation. See Chapter 6 of Report 1, phase II.

Estimated Construction Costs. Detail breakdown of estimated construction costs by item is given in Chapter 6 of Report 1, Phase II. Total estimated construction cost for alternative S4B is $20,986,000.

Estimated Operation Costs. Detail breakdown of estimated annual operating costs for alternative S4B is given in Chapter 6 of Report 1, Phase II. Total estimated annual operating costs are $1,947,000.

Alternative S5A

To improve toxicity and nutrient levels it is necessary to remove the ammonia and nonbiodegradable organics which are relatively untouched by the physical, biological and chemical treatment processes considered in alternative S1 through S4B. One alternative which will achieve the necessary nutrient improvements involves the combination of alternative S4A with filtration and superchlorination. When these alternatives are further combined with carbon adsorption, increased removals of nonbiodegradable organics will assure the necessary improvements in effluent toxicity. Alternative S5A, therefore, will include the physical-chemical treatment provided under alternative S4A with filtration, superchlorination and carbon adsorption.

It is anticipated that the suspended solids removal, exclusive of chemicals, under alternative S5A will be about 10 percent greater than S4A. To provide for the treatment of these solids, a 2 percent increase in the cost of solids removal, handling and disposal facilities of alternative S4A will be required, Previously built-in design tolerances limit the application of this cost increase to items 5, 7, 8 and 9 of alternative S4A.

Reductions Expected. With the completion of all the proposed existing plant, effluent pumping station and outfall improvements and the installation of high dose slaked lime chemical treatment with recarbonation, filtration, superchlorination and carbon adsorption it is expected that the following objectives can be attained at the Southeast plant:

	Alternative S5A
Parameter	**Objectives**
Toxicity	Compliance with all receiving water objectives. Approximately 90 percent survival in effluent for 90 percent of the determinations. Compliance with effluent objectives.
Nutrients	Compliance with all receiving water objectives. Approximately 94 percent removal of total nitrogen (N) entering plant. Compliance with effluent objectives. Approximately 95 percent removal of total phosphorus (P) entering plant. Compliance with effluent objectives.
Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives. Compliance with effluent objectives.
Pesticides	Compliance with all receiving water objectives for Lindane, Heptachlor-epoxide and Dieldrin. Less than 0.006 μg/l D.D.T. (including D.D.E. and D.D.D.) in the receiving water. Compliances with all receiving water objectives
Metals	Compliance with all receiving water objectives. Compliance with all effluent objectives.

It is also anticipated that alternative S5A will result in a 94 percent BOD and COD reduction, a 98 percent suspended solids reduction and a 100 percent ammonia reduction. After disinfection the effluent is expected to have a coliform level of 2.2/100 ml with a consistently high degree of virus removal.

Description of Construction. Alternative S5A, which involves high dose slaked lime chemical treatment, recarbonation, filtration, superchlorination and carbon adsorption plus existing plant, effluent pumping station and outfall improvements includes the following sewage treatment construction:

1 Construction of improvements to the existing Southeast plant as listed in items 1-11, 13-18 under alternative S1, Report 1, Phase II.

2. Installation of chemical storage and feeding facilities as recommended in item 2, alternative S4A, Report 1, Phase II.

3. Installation of preaeration flocculator recycling facilities as recommended in item 3, alternative S4A, Report 1, Phase II.

4. Installation of recarbonation facilities including fiberglas carbon dioxide storage tanks and equipment and apparatus required to introduce the gaseous CO_2 to the flow downstream from the sedimentation tank effluent control valves and upstream from the dual-media filters. The recarbonation system will be as recommended in item 4, alternative S4A, Report 1, Phase II, except that it will be provided with a total of 8-1/2 minutes of detention time.

5. Installation of eleven bifurcated dual-media filters each of which will have 800 sq ft of surface area. The filtration system will be installed downstream from the recarbonation

facilities and will include air-water backwash facilities and automatic head loss and backwash controls. Backwash water will be provided by two pumps, each capable of providing one-half of a filter with 12 mgd of filter effluent.

It is anticipated that backwashing will require from 7 to 10 percent of the filtered effluent. A backwash holding tank will be provided to allow the backwashing to be pumped into the plant stream at a rate of flow which can be assimilated without upset. Backwashings will be discharged into the raw sewage flow upstream form the primary sedimentation tanks. Any 10 filters will be capable of handling the peak wet weather flow. Instrumentation signals and controls will be tied into the centralized control system.

6. Modification of chlorination facilities including additional chlorination capacity for superchlorination, new chlorine handling pipelines, new superchlorination diffusers and control instrumentation. Chlorination capacity additions will be based on prechlorination at existing levels for all flows and superchlorinating with 170 mg/l Cl_2 for flows up to approximately 50 mgd and will consist of two additional 40 ton liquid storage tanks, new vandal proof storage housing facilities and twelve additional 8000 lb/day evaporator-chlorinator combinations. Superchlorination chlorine vacuum piping will be designed to allow two units to stand by for any of the other 11 superchlorination combinations. Two existing prechlorination evaoprator-chlorinator combinations will be poped to standby for each other.

Chlorine handling pipelines will be changed to handle chlorine gas under vacuum with the prechlorination injector and 11 superchlorination injectors located in the field at the point of application. Superchlorination diffusers will be located immediately downstream from the dual-media filter head loss control valves. Each superchlorination diffuser will consist of a short pipe applicator followed immediately by an 'in-line', propeller type mixer. Each diffuser will be capable of handling the complete output of an evaporator-chlorinator combination. Eleven injector water pumps will provide up to 350 gpm for each superchlorination injector. Instrumentation signals and controls will be tied into the centralized control system.

7. Installation of a superchlorination contact chamber designed to provide six and one-half minutes of detention time at PWWF. Chamber will be designed in several compartments so that each may be taken out-of-service periodically for cleaning. Chamber design will minimize short circuiting, provide a positive head for superchlorination mixers and a positive suction head for carbon adsorption system influent pumps and superchlorination injector water pumps.

8. Installation of a carbon adsorption system complete with ten 30 ft diameter, 50 ft high carbon towers designed to provide 40 minutes of empty bed detention time at a downward application rate of 4 gpm/sq ft at ADWF with one standby tower and sufficient hydraulic capacity to handle PWWF application; influent pumps; effluent collection and discharge chamber; and complete carbon regeneration facilities. Each tower will be provided with 410 tons of 16 x 40 mesh granular activated carbon, effluent and air backwash facilities, adequate space for bed expansion during backwash and facilities for draining and recharging the carbon bed and will be designed for a 50 psi working pressure.

A common effluent collection chamber will provide a suction supply for two 7 mgd backwash water pumps. It is anticipated that backwashing will require from 3 to 4 percent of the sorption effluent. Backwashing will be controlled by system head loss level. Backwashings will be collected in the filter backwashing holding tank and pumped back into the plant upstream from the primary sedimentation tanks. Water level in the collection chamber will be controlled by the operation of the existing effluent pumping station. Carbon regeneration facilities will consist of transportation equipment, a multiple hearth furnace regenerator, a quench tank and carbon make-up storage and feeding equipment. Carbon will be regenerated at 1650° to 1700°F. Carbon regeneration will be controlled by COD removal efficiency. Carbon exhaust is assumed to be 100 lbs carbon per 50 lbs COD removed with 7-1/2 percent make-up.

The complete adsorption facilities will be housed in an enclosed structure with suitable ventilation and equipment access facilities and adequate noise and odor control. All flow and backwash controls will be automatic. Instrumentation signals and controls will be connected to the centralized control system.

In addition to these sewage treatment process improvements the following plant improvement should be made to the solids treatment and disposal facilities at the Southeast plant:

9. Construction of solids gravity thickening facilities as listed in item 5, alternative S4A, Report 1, Phase II plus a 2 percent allowance for increased solids.

10. Utilization of digesters 8 and 9 as raw sludge holding tanks with high energy gas mixers as recommended in item 6, alternative S4A, Report 1, Phase II.

11. Renovation and enlargement of the existing sludge filtering system as recommended in item 7, alternative S4A, Report 1, Phase II plus a 2 percent allowance for increased solids.

12. Installation of vacuum filter filtrate electrolytic treatment facilities as recommended for item 8, alternative S4A, Report 1, Phase II plus a 2 percent allowance for increased solids.

13. Installation of two 147 dry tons per day, 22.25 ft diameter, 9 hearth incinerators, all similar but 2 percent larger than facilities recommended for item 9, alternative S4A, Report 1, Phase II.

Description of Operation. The high dose slaked lime chemical treatment process plus recarbonation, filtration, superchlorination, carbon adsorption and existing plant effluent pumping station and outfall improvements proposed under alternative S5A will require more manpower than any of the other alternatives considered so far for the Southeast plant. It is anticipated the calcium oxide handling and mixing equipment, recarbonation equipment, filtration and superchlorination equipment, carbon adsorption equipment and the solids thickening filtering and incinerating facilities will require the equivalent of five full-time maintenance operators in addition to the other personnel required for alternative S1, Report 1, Phase II. With continuous duty, these maintenance operator positions will entail the addition of at least 25 new personnel.

Alternative S5A will require large amounts of power. Power use greater than that of alternative S1, Report 1, Phase II will result from the chemical handling facilities, underflow recycling, carbon dioxide diffusion, filter backwash, chlorine evaporation, chlorine diffusion, carbon adsorption pumping, adsorption tower backwash, regenerated carbon handling, additional solids thickening, filtering and incineration facilities. If the preaeration underflow recycling averages 10 percent of the plant flow, filter backwash 8-1/2 percent and carbon adsorption backwash 3-1/2 percent, it is estimated that the extra power over 1969-70 use will involve the continuous running of approximately 4200 horsepower. Except for carbon regeneration and solids incineration fuel costs, other utility costs are expected to remain about the same as for alternative S1, Report 1, Phase II. Carbon regeneration utility costs, exclusive of power, are expected to average about $90/day. Incinerators are expected to use about 3600 Therms/day of natural gas.

Influent chlorine use is expected to remain the same as alternative S1, Report 1, Phase II. Superchlorination chlorine requirements are expected to average about 170 mg/l or 51,000 lbs/day. Salt requirements for odor control will be approximately 6000 lbs per day and it is estimated that alternative S5A will require the use of 57 tons per day of new calcium oxide. Carbon dioxide use is expected to average about 9.2 tons/day and activated carbon makeup about 3.1 tons/day. No chemicals will be required for filter cake production.

Changes in maintenance and repair costs between alternatives S1, Report 1, Phase II and alternative S5A are expected to parallel the increased investment in equipment and facilities.

Screening and grit disposal costs are expected to be the same as alternative S4A, Report 1, Phase II. Incineration system is expected to produce an average of approximately 128 tons per day of damp ash (20 percent moisture) to be hauled to land fill disposal.

Estimated Construction Costs. Estimated construction costs, including engineering and contingencies, for alternative S5A which provides for existing plant, effluent pumping station and outfall improvements plus high dose slaked lime chemical treatment, recarbonation, filtration, superchlorination and carbon adsorption are presented below. Costs are given for each item discussed in the preceding section and are based on 1971 prices:

Alternative S5A

Solids Treatment		Solids Treatment	
1.	$ 5,263,000	9.	$ 1,225,000
2.	165,000	10.	165,000
3.	90,000	11.	1,040,000
4.	1,410,000	12.	474,000
5.	6,270,000	13.	4,636,000
6.	2,430,000	Subtotal	$ 7,540,000
7.	875,000		
8.	10,650,000	TOTAL	$34,693,000
Subtotal	$27,153,000		

The costs above do not include any allowance for the purchase of land required for structures for filtration, superchlorination or carbon adsorption. If all work must be completed by 1975, these costs should be increased by approximately 25 percent of $8,700,000.

Estimated Operation Cost. Estimated annual operating costs for existing plant, effluent pumping station and outfall improvements plus high dose lime chemical treatment with recarbonation, filtration, superchlorination and carbon adsorption are based on 1971 prices and are as follows:

Alternative S5A

Labor	$ 891,000
Electric power	304,000
Other utilities	136,000
Chemicals	1,724,000
Maintenance, repair and supplies	181,000
Screening and grit disposal	3,000
Other solids disposal	210,000
TOTAL	$3,449,000

Alternative S5B

A second combination of treatment processes which will improve effluent toxicity and nutrient levels involves combining the improved existing plant, effluent pumping station and outfall physical treatment facilities with biological oxidation to nitrification, denitrification with chemical addition, filtration and carbon adsorption. This laternative utilizes biological treatment to its fullest extent and relies on chemical addition only as required to assure phosphorus removal. It is anticipated that this system will result in a 28 percent increase in solids generation, including chemicals, over the biological treatment system of alternative S3, Report 1, Phase II.

Because of increased solids production, solids treatment for alternative S5B will differ from alternative S3. Waste activated and denitrification sludges are expected to increase the flotation thickener surface to 2300 sq ft at a loading rate of 25 lbs/sq ft and the number of digesters to be modified from 4 to 5. With 5 digesters in service the digested loading is expected to be 0.114 lbs/cu ft/day with a 27.5 day detention. Digested sludge production will be approximately 163,000 gpd of 6 percent solids. Heat treatment conditioning will be utilized to improve the dewaterability of the sludge. Maximum heat conditioning requirements will be approximately 17,000 gph. With heat treatment conditioning one-half of the existing filtering equipment will be expected to operate at a loading rate of 10 lbs (dry)/sq ft/hr and produce a 35 percent solids filter cake. Maximum supernatant, heat treatment decant and filtrate production will be 21,000 gph.

Reductions Expected. With the completion of all the proposed existing plant, effluent pumping station and outfall improvements and the installation of biological oxidation to nitrification, denitrification with chemical addition, filtration and carbon adsorption it is expected that the following objectives can be attained at the Southeast plant:

Alternative S5B

Parameter	Objectives
Toxicity	Compliance with all receiving water objectives. Approximately 100 percemt survival in effluent for 90 percent of the determinations. Compliance with effluent objectives.
Nutrients	Compliance with all receiving water objectives. Approximately 96 percent removal of total nitrogen (N) entering plant. Compliance with effluent objectives. Approximately 98 percent removal of total phosphorus (P) entering plant. Compliance with effluent objectives.

Phenols	Compliance with all receiving water objectives.
Sulfides	Compliance with all receiving water objectives.
	Compliance with effluent objectives.
Pesticides	Compliance with all receiving water objectives for Lindane, Heptachlor-epoxide and Dieldrin. Less than 0.006 μg/l D.D.T. (including D.D.E. and D.D.D.) in the receiving water. Compliance with all receiving water objectives.
Metals	Compliance with all receiving water objectives.
	Compliance with all effluent objectives.

It is also anticipated that alternative S5B will result in a 99 percent BOD reduction, a 98 percent COD reduction, a 99 percent suspended solids reduction and a 94 percent ammonia reduction. After disinfection the effluent is expected to have a coliform level of 2.2/100 ml with a consistently high degree of virus removal.

Description of Construction. Alternative S5B, which involves biological oxidation to nitrification, denitrification with chemical addition, filtration and carbon adsorption plus existing plant, effluent pumping station and outfall improvements, includes the following sewage treatment construction:

1. Construction of improvements to the existing Southeast plant as listed in items 1-11 and 13-18, alternative S1, Report 1, Phase II.

2. Installation of an activated sludge biological oxidation treatment system complete with nitrifying aeration facilities and secondary sedimentation tanks. The biological oxidation treatment system will be similar to the system described in item 2, alternative S3, Report 1, Phase II, except for the doubling of the tank capacity to accommodate the 25 lbs applied BOD/1000 cu ft per day loading rate, the 50 percent increase in blower capacity to maintain an aeration air rate of 1800 cu ft per lb of BOD removed and the utilization of double concentric weirs for effluent collection.

3. Installation of a denitrification system complete with four denitrification tanks and four circular final sedimentation tanks. Each denitrification tank will be approximately 120 ft long, 50 ft wide and 15 ft deep, and will be divided by curtain walls into compartments as required for proper mixing and stirring. At ADWF the detention time in the tanks will be about 110 minutes. Tank sizing assumes a volatile mixed liquor solids concentration of 2100/mg/l and utilizes a loading rate of 0.2 lbs nitrate as N/day/lb MLVSS.

Nitrified effluent from the secondary sedimentation tanks will be mixed with return sludge in a channel ahead of the denitrifying tanks. As the mixed liquor passes through the tank it will be constantly stirred and mixed to keep all solids in suspension. Methanol will be added at the beginning of each tank and immediately mixed with the nitrified influent and returned sludge. Provisions will also be included to add methanol along each tank. Methanol addition will be at the rate of 3.2 lbs/lb of applied nitrate as N. During denitrification, nitrates are reduced to nitrogen gas. Mixed liquor from the denitrification tanks will be discharged to the final sedimentation tanks by open channel where mixing and agitation will be provided to keep the solids in suspension, and to scrub the nitrogen gas from the liquid. Alum will be added to the mixed liquor just upstream from the final sedimentation tanks for removal of phosphorus and provisions will be included for final pH adjustment. It is anticipated the average active alumina (Al_2O_3) rate of application will be 27 mg/l. Provisions will be made for feeding at a peak rate of 40 mg/l. Final sedimentation will take place in four circular reinforced concrete tanks. Each tank will have a diameter of 120 ft and a side water depth of 20 ft. Any three tanks will be able to handle the PWWF with an overflow rate of 2000 gal per sq ft per day. The tanks will be arranged in a single battery of four fed from the denitrifying mixed liquor channel by a single center channel. The influent and discharge hydraulic losses at the final sedimentation tanks will be carefully balanced to insure that all tanks perform equally at all conditions of flow.

Mixed liquor will be introduced at the center of the tanks through a baffling structure, and effluent collected by double concentric weirs arranged to provide maximum solids removal efficiency. Suldge will be continuously removed by a rotating hollow tube filled with

orifices and a squeegee. The rate of sludge withdrawal will be controlled in response to signals from automatic sensors to maintain the sludge blanket at a preset level. Sludge will be withdrawn by self-priming non-clog pumps and discharged to the sludge return channel of the denitrification tanks. Convenient means will be provided for sampling and visual observation of the sludge. Excess activated denitrification sludge, if any, will be wasted through a meter directly to the waste activated sludge flotation thickening tanks.

Automatic skimming will be provided on each final sedimentation tank with the scum removed directly to ejectors for discharge to the waste activated sludge force main. Effluent from the final sedimentation tanks will be discharged via closed channels directly to the dual media filters.

All of the denitrification treatment facilities will be uncovered. All instrument signals and controls will be transmitted to the centralized control center.

4. Installation of eleven bifurcated dual-media filters complete with backwash facilities as recommended in item 5, alternative S5A.

5. Installation of ten carbon adsorption towers complete with influent pumps, backwashing facilities, carbon regeneration facilities, housing and controls as recommended in item 8, alternative S5A.

6. Relocation of pre and postchlorination injectors and postchlorination diffuser and modification of chlorine handling piping and equipment as recommended in item 12, alternative S1, Report 1, Phase II, except for the relocation of the postchlorination diffuser. Postchlorination diffuser will be relocated to plant discharge sewer immediately downstream from the carbon tower collection chamber. Postchlorination diffuser will consist of a short pipe applicator followed immediately by an "in-line" propeller type mixer. Postchlorination injector pumps will be located directly over the carbon tower collection chamber.

In addition to these sewage treatment process improvements the following plant improvements should be made to the solids treatment and disposal facilities at the Southeast plant:

7. Installation of at least four air flotation thickening units to provide 4600 sq ft of tank surface including adequate standby. Each tank will be provided with top scum and bottom sludge collection and removal equipment, sufficient settled sewage and compressed air dissolving equipment, and adequate automatic controls. Tanks will be completely housed and provided with positive ventilation and odor control equipment. Thickener overflow will be directed to the primary sedimentation tank influent.

8. Construction of improvements to the existing Southeast plant as listed in items 19-21 and 23, alternative S1, Report 1, Phase II, with the electrolytic waste treatment process for digester supernatant, heat conditioning decant and filtrate increased in capacity to 21,000 gph.

9. Modification of digester 7 as recommended in item 11, alternative S4B, Report 1, Phase II.

10. Installation of sludge heat conditioning facilities including solids disintegration, heat exchangers, pumps, control valves, reactor vessels, treated sludge storage and decanting tanks, pressure ventilation and deodorization, and necessary controls. Facilities will have a capacity of 17,000 gph.

Description of Operation. The biological treatment process with oxidation to nitrification, denitrification with chemical addition, filtration, carbon adsorption and existing plant, effluent pumping station and outfall improvements proposed under alternative S5B will require the same amount of manpower required by alternative S5A. It is anticipated the biological nitrification and denitrification facilities, filtration facilities, carbon adsorption equipment, waste activated sludge flotation thickening facilities, digester gas circulation equipment and sludge conditioning and disposal facilities will require the equivalent of five full-time maintenance operators in addition to the other personnel required for alternative S1, Report 1, Phase II. With continuous duty, these positions will entail the addition of at least 25 new personnel.

Alternative S5B will require the greatest amount of power of all other alternatives. Extra power use will result from the aeration and agitation air blowers and return activated sludge pumps of the biological oxidation system with nitrification, the agitation air blowers and return activated sludge pumps of

the denitrification system, the intermediate and final sedimentation tank drives, the waste sludge pumps of both systems, the filter backwash pumping, the regenerated carbon handling, the flotation thickener pumps, compressors and ventilating and deodorizing equipment, the heat conditioning equipment and the larger electrolytic treatment facilities. If the return sludge pumping in both systems, the filter backwash pumping and the carbon adsorption backwash pumping average 25, 8-1/2 and 3-1/2 percent, respectively, of plant flow, it is estimated that the extra power over 1969-70 use will involve the continuous running of approximately 7800 horsepower. Except for carbon regeneration fuel costs, other utility costs are expected to remain about the same as for alternative S1, Report 1, Phase II. Carbon regeneration utility costs, exclusive of power, are expected to average about $90/day.

Influent and effluent chlorine use is expected to remain the same as alternative S3, Report 1, Phase II. Salt requirements for odor control will be approximately 15,000 lbs/day. Activated carbon make-up will average about 1.7 tons/day, methanol use about 4800 gal/day and liquid alum for phosphorus removal about 49 tons/day. No chemicals will be required for filter cake production.

Changes in maintenance and repair costs between alternative S1, Report 1, Phase II and alternative S5B are expected to parallel the increased investment in equipment and facilities.

Screnning and grit disposal costs are expected to be the same as alternative S1, Report 1, Phase II. It is anticipated that alternative S5B will require one-half of the existing filters to be operated approximately 11 hours per day, 6 days per week. Filter cake production, when prorated to a continuous basis, will average 116.5 tons per day.

Estimated Construction Costs. Estimated construction costs, including engineering and contingencies for alternative S5B which provides for existing plant, effluent pumping station and outfall improvements plus biological oxidation to nitrification, denitrification with chemical addition, filtration and carbon adsorption are presented below. Costs are given for each item discussed in the preceding section and are based on 1971 prices.

Alternative S5B

Sewage Treatment		Solids Treatment	
1.	$ 5,263,000	7.	$ 1,050,000
2. 3.	22,800,000	8.	2,244,000
		9.	115,000
4.	6,270,000	10.	2,160,000
5.	10,650,000	Subtotal	$ 5,569,000
6.	63,000	TOTAL	$50,615,000
Subtotal	$45,046,000		

The costs above do not include any allowance for the purchase of land required for structures for biological oxidation to nitrification, denitrification with chemical addition, filtration or carbon adsorption. If all work must be completed by 1975, these costs should be increased by approximately 25 percent or $12,650,000.

Estimated Operation Costs. Estimated annual operating costs for existing plant effluent pumping station and outfall improvements plus biological oxidation to nitrification, denitrification with chemical addition, filtration and carbon adsorption are based on 1971 prices and are as follows:

Alternative S5B

Labor	$ 891,000
Electric power	539,000
Other utilities	44,000
Chemicals	1,271,000
Maintenance, repair and supplies	266,000
Screening and grit disposal	17,000
Ohter solids disposal	191,000
TOTAL	$ 3,219,000

Summary

Table 3-5 presents the predicted plant performance for each of the alternatives proposed for the Southeast plant, table 3-6 summarizes estimated construction and operating costs of the alternatives.

Table 3 - 5

**Predicted Performance of Alternative Treatment Processes
Southeast Water Pollution Control Plant**

Alternative	Toxicity		Nutrients			Phenols	Sulfides	
	Percent 96-hr TLm conc wastes in rec water	Percent survival in effluent 90 percent of time	Rec water chlorophyll level mg/l	Percent removal total N in influent	Percent removal total P in influent	Rec water conc mg/l	Rec water conc mg/l	Effluent conc mg/l
S1	< 5[b]	10[a]	< 50[b]	10[a]	10[a]	<0.03[b]	<0.05[b]	< 0.1[b]
S2A	< 5[b]	15[a]	< 50[b]	10[a]	20[a]	<0.03[b]	<0.05[b]	<0.1[b]
S2B	<5[b]	25[a]	< 50[b]	15[a]	50[a]	< 0.03[b]	<0.05[b]	<0.1[b]
S3	<5[b]	30[a]	<50[b]	30[a]	35[a]	< 0.03[b]	<0.05[b]	<0.1[b]
S4A	<5[b]	40[a]	< 50[b]	20[a]	85[a]	<0.03[b]	<0.05[b]	<0.1[b]
S4B	< 5[b]	30[a]	<50[b]	20[a]	85[a]	< 0.03[b]	<0.05[b]	<0.1[b]
S5A	< 5[b]	90[b]	< 50[b]	94[b]	95[b]	< 0.03[b]	< 0.05[b]	<0.1[b]
S5B	<5[b]	100[b]	< 50[b]	96[b]	98[b]	<0.03[b]	<0.05[b]	<0.1[b]

Alternative	Pesticides				Metals				
	Receiving water concentrations				Receiving water condentrations				
	Lindane µg/l	Heptachlor epoxide µg/l	D.D.T. (incl D.D.E. and D.D.D.) µg/l	Dieldrin µg/l	Hexavalent chromium mg/l	Total chromium mg/l	Lead mg/l	Copper mg/l	Zinc mg/l
S1	< 0.002[b]	<0.002[b]	0.010	< 0.003[b]	<0.5[b]	<1.0[b]	< 0.05[b]	< 0.05[b]	<0.1[b]
S2A	<0.002[b]	<0.002[b]	0.010	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
S2B	< 0.002[b]	<0.002[b]	0.010	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	< 0.05[b]	<0.1[b]
S3	<0.002[b]	<0.002[b]	0.010	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
S4A	<0.002[b]	<0.002[b]	0.010	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
S4B	<0.002[b]	<0.002[b]	0.010	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
S5A	<0.002[b]	<0.002[b]	< 0.006[b]	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]
S5B	<0.002[b]	<0.002[b]	<0.006[b]	<0.003[b]	<0.5[b]	<1.0[b]	<0.05[b]	<0.05[b]	<0.1[b]

Alternative	Effluent concentrations									
	Cadmium mg/l	Aluminum mg/l	Total chromium mg/l	Copper mg/l	Zinc mg/l	Iron mg/l	Nickel mg/l	Lead mg/l	Mercury mg/l	Aresnic mg/l
S1	-	5.0	4.0[a]	0.35[a]	< 1.0[b]	2.5[a]	< 5.0[b]	< 0.05[b]	0.200	< 3.0[b]
S2A	-	4.5	3.5[a]	0.30[a]	< 1.0[b]	2.5[a]	< 5.0[b]	< 0.05[b]	0.200	< 3.0[b]
S2B	-	3.0	2.5[a]	0.20[a]	< 1.0[b]	1.5[a]	< 5.0[b]	< 0.05[b]	0.050	< 3.0[b]
S3	-	2.5	2.0[a]	0.15[a]	< 1.0[b]	2.0[a]	< 5.0[b]	< 0.05[b]	0.100	< 3.0[b]
S4A	< 0.01[b]	< 1.0[b]	< 1.0[b]	< 0.05[b]	<1.0[b]	< 1.0[b]	< 5.0[b]	< 0.05[b]	<0.005[b]	< 3.0[b]
S4B	<0.01[b]	< 1.0[b]	< 1.0[b]	<0.05[b]	< 1.0[b]	< 1.0[b]	< 5.0[b]	< 0.05[b]	<0.005[b]	< 3.0[b]
S5A	<0.01[b]	< 1.0[b]	< 1.0[b]	<0.05[b]	< 1.0[b]	<1.0[b]	< 5.0[b]	< 0.05[b]	<0.005[b]	< 3.0[b]
S5B	< 0.01[b]	< 1.0[b]	< 1.0[b]	<0.05[b]	<1.0[b]	< 1.0[b]	<5.0[b]	< 0.05[b]	<0.005[b]	<3.0[b]

[a] Meets minimum stipulated objective.

[b] Meets maximum stipulated objective.

Table 3 - 6

Estimated Construction and Operating Costs of Alternative Treatment Processes Southeast Water Pollution Control Plant

Alternative	Estimated construction cost, dollars[a]	Estimated annual operating cost, dollars
S1	7,602,000	1,134,000
S2A	10,793,000	1,311,000
S2B	10,448,000	1,240,000
S3	18,858,000	1,485,000
S4A	13,543,000	2,014,000
S4B	20,986,000	1,947,000
S5A	34,693,000	3,449,000
S5B	50,615,000	3,219,000

[a]No land costs included. See appendix D for additional land area required for each alternative.

APPENDIX A

PREDICTED SEWAGE TREATMENT PROCESS

PERFORMANCES

APPENDIX A

PREDICTED SEWAGE TREATMENT PROCESS PERFORMANCES

	Alternatives		
1. Existing Facilities with Improvements	N1	R1	S1
Basic Loading Factors, mg/l			
BOD	195	180	273
COD	480	490	800
Suspended solids	194	190	420
Ammonia as N	1.5	22	17
Total nitrogen as N	34	37	49
Total phosphorus as P	13	17	15
Primary solids separation after improvements			
Process removal, percent			
BOD	35	35	35
COD	35	35	35
Suspended solids	65	65	65
Ammonia as N	0	0	0
Total nitrogen as N	10	10	10
Total phosphorus as P	10	10	10
Effluent concentration, mg/l			
BOD	127	117	178
COD	312	318	520
Suspended solids	68	67	147
Ammonia as N	15	22	17
Total nitrogen as N	31	33	44
Total phosphorus as P	12	15	13
2. Dissolved Air Flotation		R2	S2A
Basic loading factors, mg/l			
BOD		180	273
COD		490	800
Suspended solids		190	420
Ammonia as N		22	17
Total nitrogen as N		37	49
Total phosphorus as P		17	15

2. Dissolved Air Flotation (Continued)

	R2	S2A
Primary solids separation after improvements		
Process removal, percent		
BOD	35	35
COD	35	35
Suspended solids	65	65
Ammonia	0	0
Total nitrogen as N	10	10
Total phosphorus as P	10	10
Concentration in effluent, mg/l		
BOD	117	178
COD	318	520
Suspended solids	67	147
Ammonia as N	22	17
Total nitrogen as N	33	44
Total phosphorus as P	15	13
Dissolved air flotation		
Process removal, percent		
BOD	7.5	7.5
COD	7.5	7.5
Suspended solids	40	40
Ammonia as N	0	0
Total nitrogen as N	0	0
Total phosphorus as P	12.5	12.5
Effluent concentration, mg/l		
BOD	108	164
COD	294	480
Suspended solids	40	88
Ammonia as N	22	17
Total nitrogen as N	33	44
Total phosphorus as P	13	11
Total removals, percent		
BOD	40	40
COD	40	40
Suspended solids	78	78
Ammonia as N	0	0
Total nitrogen as N	10	10
Total phosphorus as P	20	20

3. Low Ferric chloride Chemical Treatment	N2	R3	S2B
Basic loading factors, mg/l			
BOD	195	180	273
COD	480	490	800
Suspended solids	194	190	420
Ammonia as N	15	22	17
Total nitrogen as N	34	37	49
Total phosphorus as P	13	17	15
Primary solids separation with low dose ferric chloride			
Process removal, percent			
BOD	40	40	40
COD	40	40	40
Suspended solids	75	75	75
Ammonia as N	0	0	0
Total nitrogen as N	15	15	15
Total phosphorus as P	50	50	50
Effluent concentration, mg/l			
BOD	117	108	164
COD	288	294	480
Suspended solids	49	48	105
Ammonia as N	15	22	17
Total nitrogen as N	29	31	42
Total phosphorus as P	6	8	7

4. Low Lime Chemical Treatment	N3
Basic loading factors, mg/l	
BOD	195
COD	480
Suspended solids	194
Ammonia as N	15
Total nitrogen as N	34
Total phosphorus as P	13
Primary solids separation with low dose slaked lime	
Process removal, percent	
BOD	45
COD	45
Suspended solids	80
Ammonia as N	0
Total nitrogen as N	15
Total phosphorus as P	50

4. Low Lime Chemical Treatment
Primary solids separation with low dose slaked lime (Continued)

	N3
Effluent concentration, mgl	
BOD	108
COD	265
Suspended solids	39
Ammonia as N	15
Total nitrogen as N	29
Total phosphorus as P	6

5. Carbonaceous biological oxidation	R4A	S3
Basic loading factors, mg/l		
BOD	180	273
COD	490	800
Suspended solids	190	420
Ammonia as N	22	17
Total nitrogen as N	37	49
Total phosphorus as P	17	15
Primary solids separation after improvements		
Process removal, percent		
BOD	35	35
COD	35	35
Suspended solids	65	65
Ammonia as N	0	0
Total nitrogen as N	10	10
Total phosphorus as P	10	10
Effluent concentration, mg/l		
BOD	117	178
COD	318	520
Suspended solids	67	147
Ammonia as N	22	17
Total nitrogen as N	33	44
Total phosphorus as P	15	13
Carbonaceous biological oxidation (activated sludge)		
Process removal, percent		
BOD	85	85
COD	70	70
Suspended solids	65	65
Ammonia as N	10	10
Total nitrogen as N	20	20
Total phosphorus as P	25	25

5. Carbonaceous biological oxidation

Carbonaceous biological oxidation activated sludge (Continued)

	R4A	S3
Effluent concentration, mg/l		
BOD	18	27
COD	96	156
Suspended solids	24	52
Ammonia as N	20	15
Total nitrogen as N	26	35
Total phosphorus as P	11	10
Total removals, percent		
BOD	90	90
COD	80	80
Suspended solids	87.5	87.5
Ammonia as N	10	10
Total nitrogen as N	30	30
Total phosphorus as P	35	35

6. High Dose Lime Chemical Treatment

	N4A	R4B	S4A
Basic loading factors, mg/l			
BOD	195	180	273
COD	480	490	800
Suspended solids	194	190	420
Ammonia as N	15	22	17
Total nitrogen as N	34	37	49
Total phosphorus as P	13	17	15
Primary solids separation with high dose lime			
Process removal, percent			
BOD	70	70	70
COD	60	60	60
Suspended solids	87.5	87.5	87.5
Ammonia as N	0	0	0
Total nitrogen as N	20	20	20
Total phosphorus as P	85	85	85
Effluent concentration, mgl			
BOD	58	54	82
COD	192	196	320
Suspended solids	24	24	52
Ammonia as N	15	22	17
Total nitrogen as N	27	30	39
Total phosphorus as P	2.0	2.5	2.2

7. High Ferric Chloride Chemical Treatment with Filtration

	N4B	S4B
Basic loading factors, mg/l		
BOD	195	273
COD	480	800
Suspended solids	194	420
Ammonia as N	15	17
Total nitrogen as N	34	49
Total phosphorus as P	13	15
Primary solids separation with high dose ferric chloride		
Process removal, percent		
BOD	50	50
COD	50	50
Suspended solids	60	60
Ammonia as N	0	0
Total nitrogen as N	10	10
Total phosphorus as P	70	70
Effluent concentration, mg/l		
BOD	98	136
COD	240	400
Suspended solids	78	168
Ammonia as N	15	17
Total nitrogen as N	31	44
Total phosphorus as P	4.0	4.5
Filtration		
Process removal, percent		
BOD	30	30
COD	20	20
Suspended solids	70	70
Ammonia as N	0	0
Total nitrogen as N	12.5	12.5
Total phosphorus as P	50	50
Effluent concentration, mg/l		
BOD	68	96
COD	192	320
Suspended solids	24	52
Ammonia as N	15	17
Total nitrogen as N	27	39
Total phosphorus as P	2.0	2.2

7. High Ferric Chloride Chemical Treatment Filtration (Continued)

	N4B	S4B
Total removals, percent		
BOD	65	65
COD	60	60
Suspended solids	87.5	87.5
Ammonia as N	0	0
Total nitrogen as N	20	20
Total phosphorus as P	85	85

8. High Lime Chemical Treatment with Super-Chlorination and Carbon Adsorption

	N5	R5A	S5A
Basic loading factors, mg/l			
BOD	195	180	273
COD	480	490	800
Suspended solids	194	190	420
Ammonia as N	15	22	17
Total nitrogen as N	34	37	49
Total phosphorus as P	13	17	15
Primary solids separation with high dose lime			
Process removal, percent			
BOD	70	70	70
COD	60	60	60
Suspended solids	87.5	87.5	87.5
Ammonia as N	0	0	0
Total nitrogen as N	20	20	20
Total phosphorus as P	85	85	85
Effluent concentration, mg/l			
BOD	58	54	82
COD	192	196	320
Suspended solids	24	24	52
Ammonia as N	15	22	17
Total nitrogen as N	27	30	39
Total phosphorus as P	2.0	2.5	2.2
Recarbonation plus filtration			
Process removal, percent			
BOD	50	50	50
COD	33	33	33
Suspended solids	80	80	80
Ammonia as N	0	0	0
Total nitrogen as N	0	0	0
Total phosphorus as P	70	70	70

8. High Lime Chemical Treatment with Super-chlorination and Carbon Adsorption Recarbonation plus filtration (Continued)

	N5	R5A	S5A
Effluent concentration, mg/l			
BOD	29	27	41
COD	128	131	214
Suspended solids	5	5	10
Ammonia as N	15	22	17
Total nitrogen as N	27	30	39
Total phosphorus as P	0.6	0.8	0.7
Super-Chlorination			
Process removal, percent			
BOD	0	0	0
COD	20	20	20
Suspended solids	0	0	0
Ammonia as N	100	100	100
Total nitrogen as N	70*	90	90
Total phosphorus as P	0	0	0
Effluent concentration, mg/l			
BOD	29	27	41
COD	102	105	171
Suspended solids	5	5	10
Ammonia as N	0	0	0
Total nitrogen as N	8	3	4
Total phosphorus as P	0.6	0.8	0.7
Carbon adsorption			
Process removal, percent			
BOD	60	60	60
COD	80	80	80
Suspended solids	33	33	33
Ammonia as N	0	0	0
Total nitrogen as N	33	33	33
Total phosphorus as P	0	0	0
Effluent concentration, mg/l			
BOD	12	11	16
COD	20	21	34
Suspended solids	3	3	7
Ammonia as N	0	0	0
Total nitrogen as N	5	2	3
Total phosphorus as P	0.6	0.8	0.7

* Removal limited because of high nitrate concentration in influent.

8. High Lime Chemical Treatment with Super-Chlorination and Carbon Adsorption
Carbon adsorption (Continued)

	N5	R5A	S5A
Total removals, percent			
BOD	94	94	94
COD	94	94	94
Suspended solids	98	98	98
Ammonia as N	100	100	100
Total nitrogen as N	85*	95	94
Total phosphorus as P	95	95	95

9. High Lime Chemical Treatment with Ammonia Stripping, Biological Oxidation, and Carbon Adsorption

	R5B
Basic loading factors, mg/l	
BOD	180
COD	490
Suspended solids	190
Ammonia as N	22
Total nitrogen as N	37
Total phosphorus as P	17
Primary solids separation with high dose lime	
Process removal, percent	
BOD	70
COD	60
Suspended solids	87.5
Ammonia as N	0
Total nitrogen as N	20
Total phosphorus as P	85
Effluent concentration, mg/l	
BOD	54
COD	196
Suspended solids	24
Ammonia as N	22
Total nitrogen as N	30
Total phosphorus as P	2.5
Ammonia stripping and recarbonation	
Process removal, percent	
BOD	0
COD	0
Suspended solids	0
Ammonia as N	90
Total nitrogen as N	70
Total phosphorus as P	0

9. High Lime Chemical Treatment with Ammonia Stripping, Biological Oxidation, and Carbon Adsorption

Ammonia stripping and recarbonation (Continued)

	R5B
Effluent concentration, mg/l	
BOD	54
COD	196
Suspended solids	24
Ammonia as N	2
Total nitrogen as N	9
Total phosphorus as P	2.5
Biological oxidation	
Process removal, percent	
BOD	80
COD	60
Suspended solids	40
Ammonia as N	0
Total nitrogen as N	80
Total phosphorus as P	80
Effluent concentration, mg/l	
BOD	11
COD	78
Suspended solids	14
Ammonia as N	2
Total nitrogen as N	2
Total phosphorus as P	0.5
Effluent filtration	
Process removal, percent	
BOD	50
COD	20
Suspended solids	80
Ammonia as N	0
Total nitrogen as N	0
Total phosphorus as P	60
Effluent concentration, mg/l	
BOD	6
COD	63
Suspended solids	3
Ammonia as N	2
Total nitrogen as N	3
Total phosphorus as P	0.2

9. High Lime Chemical Treatment with Ammonia Stripping, Biological Oxidation, and Carbon Adsorption (Continued)

	R5B
Carbon adsorption	
Process removal, percent	
BOD	60
COD	80
Suspended solids	33
Ammonia as N	0
Total nitrogen as N	33
Total phosphorus as P	0
Effluent concentration, mg/l	
BOD	2
COD	13
Suspended solids	2
Ammonia as N	2
Total nitrogen as N	2
Total phosphorus as P	0.2
Total removals, percent	
BOD	99
COD	96
Suspended solids	99
Ammonia as N	91
Total nitrogen as N	94
Total phosphorus as P	93

10. Biological Nitrification-Denitrification with Carbon Adsorption

	R5C	S5C
Basic loading factors, mg/l		
BOD	180	273
COD	490	800
Suspended solids	190	420
Ammonia as N	22	17
Total nitrogen as N	37	49
Total phosphorus as P	17	15
Primary solids separation after improvement		
Process removal, percent		
BOD	35	35
COD	35	35
Suspended solids	65	65
Ammonia as N	0	0
Total nitrogen as N	10	10
Total phosphorus as P	10	10

10. Biological Nitrification-Denitrification with Carbon Adsorption
Primary solids separation after improvement (Continued)

	R5C	S5C
Effluent concentration, mg/l		
BOD	117	178
COD	318	520
Suspended solids	67	147
Ammonia as N	22	17
Total nitrogen as N	33	44
Total phosphorus as P	15	13
Biological oxidation with nitrification		
Process removal, percent		
BOD	90	90
COD	75	75
Suspended solids	80	80
Ammonia as N	100	100
Total nitrogen as N	25	25
Total phosphorus as P	23	23
Effluent concentration, mg/l		
BOD	12	18
COD	80	130
Suspended solids	13	29
Ammonia as N	0	0
Total nitrogen as N	25	33
Total phosphorus as P	12	10
Denitrification with chemical addition		
Process removal, percent		
BOD	33	33
COD	10	10
Suspended solids	25	25
Ammonia as N	0	0
Total nitrogen as N	93	93
Total phosphorus as P	95	95
Effluent concentration, mg/l		
BOD	8	12
COD	72	117
Suspended solids	10	22
Ammonia as N	0	0
Total nitrogen as N	2	2
Total phosphorus as P	0.5	0.5

10. Biological Nitrification-Denitrification with Carbon Adsorption (Continued)

	R5C	S5C
Filtration		
Process removal, percent		
BOD	50	50
COD	20	20
Suspended solids	80	80
Ammonia as N	0	0
Total nitrogen as N	0	0
Total phosphorus as P	60	60
Effluent concentration, mg/l		
BOD	4	6
COD	58	94
Suspended solids	2	4
Ammonia as N	0	0
Total nitrogen as N	2	2
Total phosphorus as P	0.2	0.2
Carbon adsorption		
Process removal, percent		
BOD	60	60
COD	80	80
Suspended solids	33	33
Ammonia as N	0	0
Total nitrogen as N	0	0
Total phosphorus as P	0	0
Effluent concentration, mg/l		
BOD	2	2
COD	12	19
Suspended solids	1	3
Ammonia as N	0	0
Total nitrogen as N	2	2
Total phosphorus as P	0.2	0.2
Total removals, percent		
BOD	99	99
COD	98	98
Suspended solids	99	99
Ammonia as N	95	94
Total nitrogen as N	94	96
Total phosphorus as P	99	98

APPENDIX B

ABBREVIATIONS

APPENDIX B

ABBREVIATIONS

No., Nos.	number, numbers
%	percent
Tlm	median tolerance limit; defined as the waste concentration, expressed in percent, at which half of the test organisms die in a stated time.
Fig.	figure
BOD	biochemical oxygen demand (5 day, 20°C)
°C	degree Celsius (formerly centigrade)
cu ft	cubic feet
/	per
gal	gallon
$	dollar, U.S.
mil	million
NBFU	National Bureau of Fire Underwriters
$Al_2 (SO_4)_3$	aluminum sulfate (alum)
lb	pound
mg/l	milli-grams per liter
ADWF	average dry weather flow
COD	chemical oxygen demand
N	nitrogen
P	phosphorus
μg/l	micro-grams per liter
DDT	1, 1, 1, - Trichloro-2, 2-bis (p-chlorophenyl) ethane
DDE	2, 2-Dichloro-2, 2-bis (p-chlorophenyl) ethylene
DDD	1, 1-Dichloro-2, 2-bis (p-chlorophenyl) ethane (sometimes called TDE)
ml	milli-liter
$FeCl_2$	ferric chloride
NaCl	sodium chloride
$Ca(OH)_2$	calcium hydroxide
gpm	gallons per minute
sq ft	square feet
°F	degrees fahrenheit
ft	feet
Cl_2	chlorine

dia	diameter
pH	hydrogen ion concentration
CO_2	carbon dioxide
gpd	gallons per day
gph	gallons per hour
MLVSS	mixed liquor volatile suspended solids.
psi	pounds per square inch

APPENDIX C

REFERENCES

APPENDIX C

REFERENCES

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APPENDIX D

ALTERNATIVE TREATMENT PROCESSES

ESTIMATED ADDITIONAL LAND REQUIREMENTS

APPENDIX D

ESTIMATED ADDITIONAL LAND REQUIREMENTS

Alternative	Additional land area required	Modification or improvement involved
	NORTH POINT WATER POLLUTION CONTROL PLANT	
N5	Sewer right-of-way	Parallel sludge force main
	Sewer right-of-way	Outfall
	3/4 acre	Dual media gravity filters
	1/2 acre	Super-chlorination contact chambers
	1-1/2 acre	Carbon adsorption towers and carbon regeneration facilities
	3/4 acre	Solid thickener tanks at Southeast plant
	RICHMOND SUNSET WATER POLLUTION CONTROL PLANT	
R5A	Sewer right-of-way	Outfall
	1/2 acre	Dual media gravity filters
	1/2 acre	Super-chlorination contact chambers
	3/4 acre	Carbon adsorption towers and carbon regeneration facilities
	1/2 acre	Incinerators
R5B	Sewer right-of-way	Outfall
	1 acre	Ammonia stripping towers
	1/2 acre	Dual media gravity filters
	3/4 acre	Carbon adsorption towers and carbon regeneration facilities
	1/2 acre	Incinerators
R5C	Sewer right-of-way	Outfall
	5 acres	Nitrifying oxidation and secondary sedimentation tanks
	2-1/2 acres	Denitrification and final sedimentation tanks
	1/2 acre	Dual media gravity filters
	3/4 acre	Carbon adsorption towers and carbon regeneration facilities
	SOUTHEAST WATER POLLUTION CONTROL PLANT	
S5A	1/2 acre	Dual media gravity filters
	1/2 acre	Super-chlorination contact chambers
	1 acre	Carbon adsorption towers and carbon regeneration facilities
	1/4 acre	Solids thickener tanks
	1/2 acre	Incinerators
S5B	6 acres	Nitrifying oxidation and secondary sedimentation tanks
	3 acres	Denitrification and final sedimentation tanks
	1/2 acre	Dual media gravity filters
	1 acre	Carbon adsorption towers and carbon regeneration facilities
	1/4 acre	Solids thickener tanks